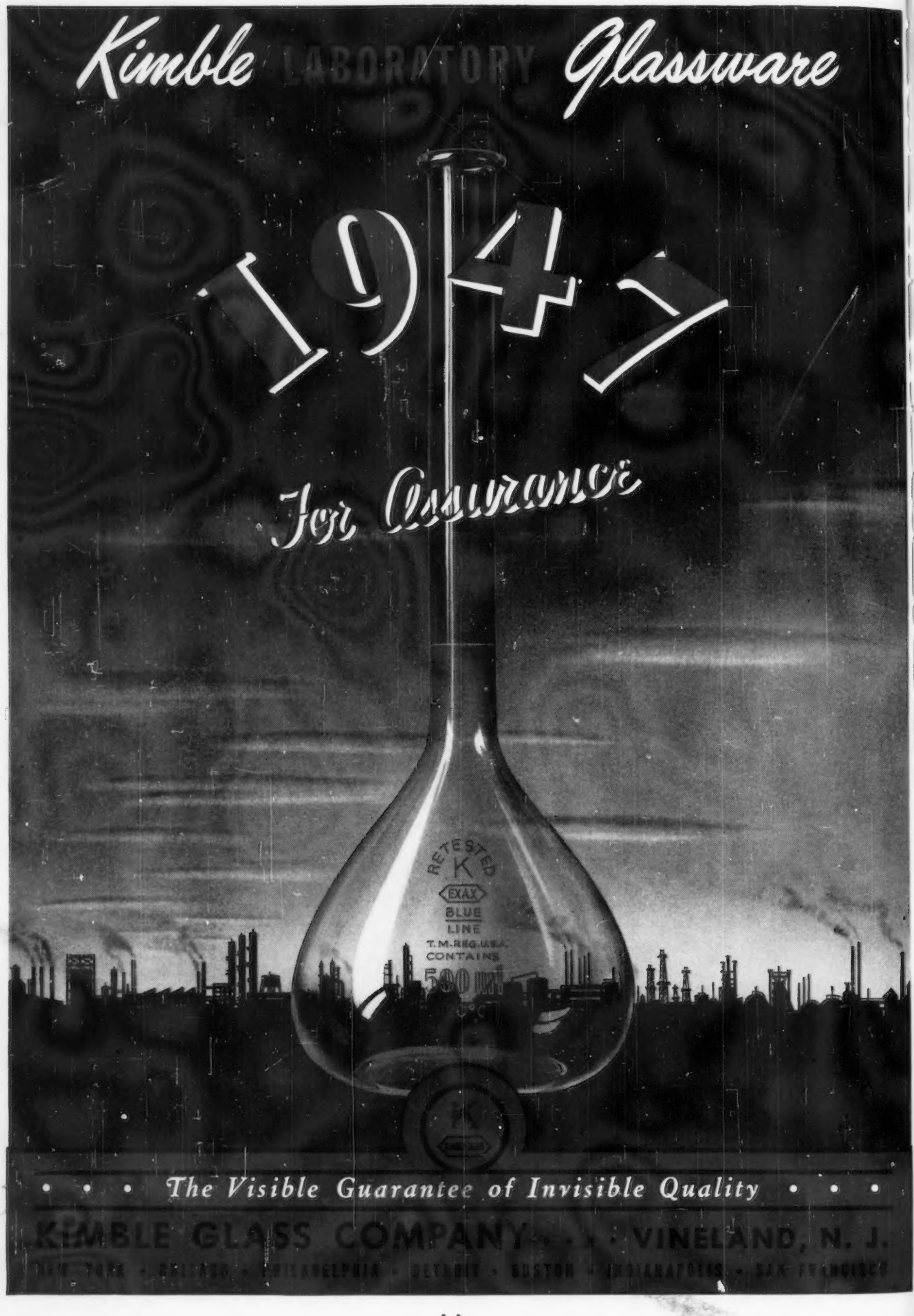
ASTM Bulletin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ASTM BULLETIN

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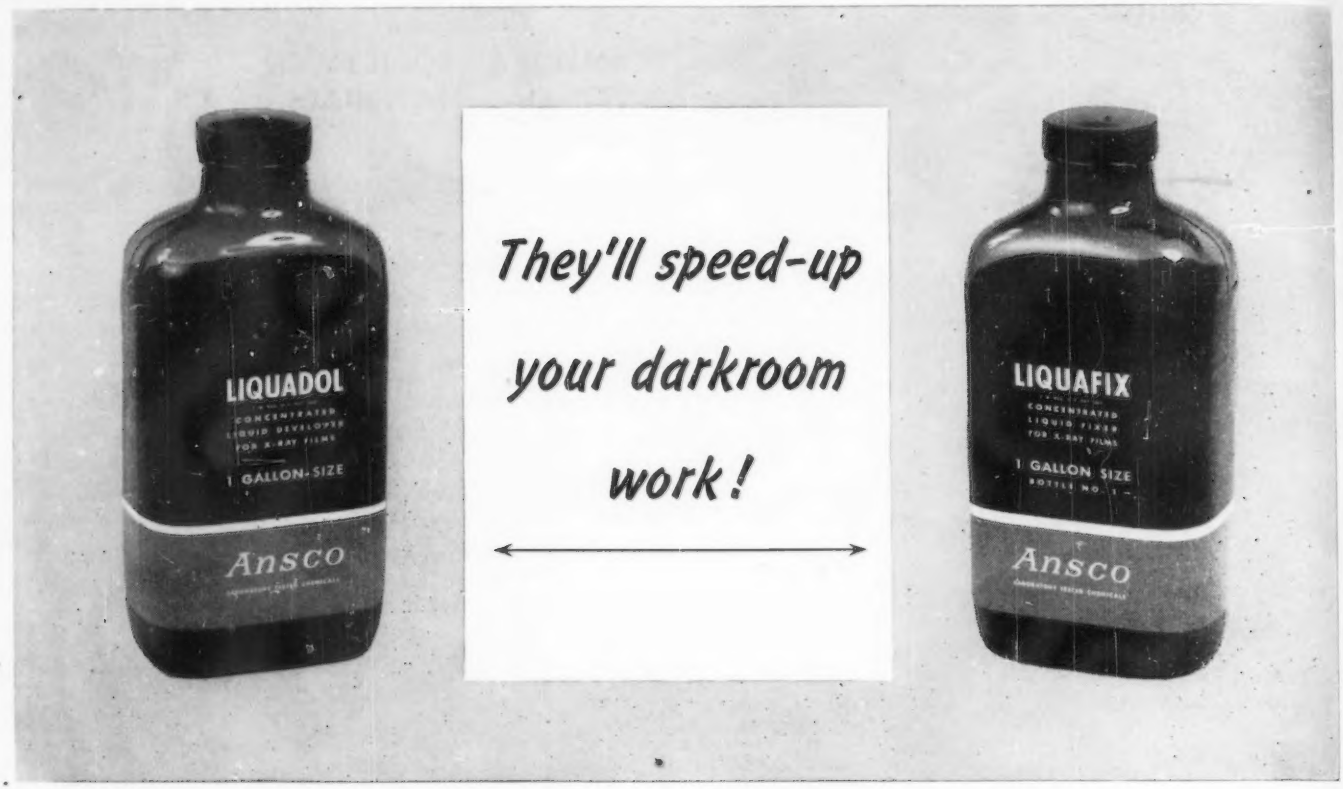
JANUARY—1947

No. 144

A quick check-up on five points—



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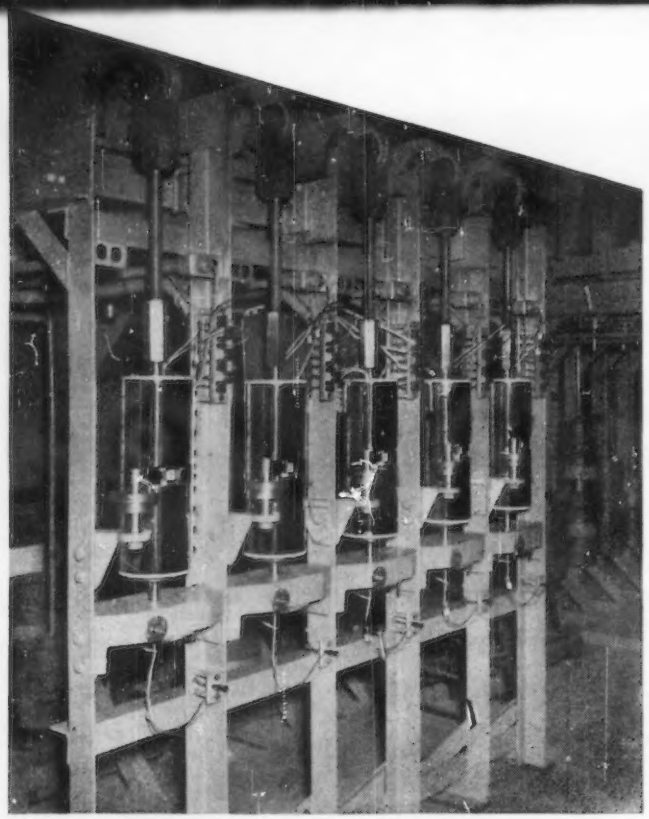

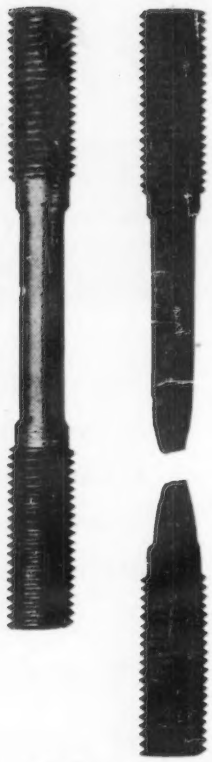

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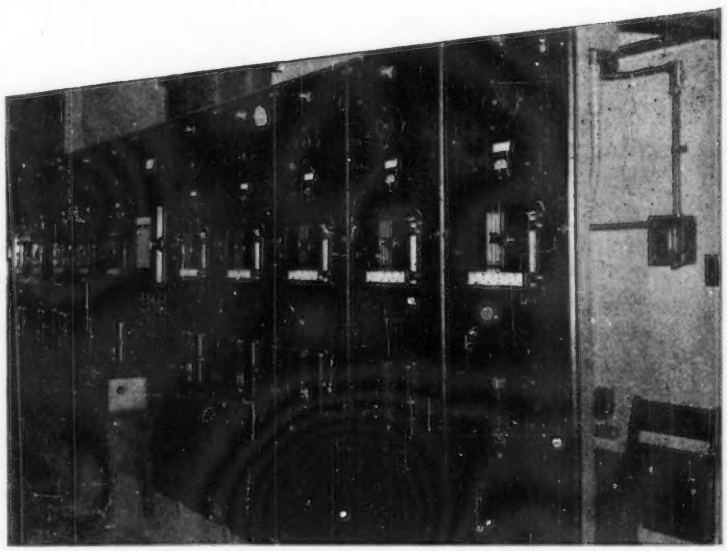

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ASTM BULLETIN

"Promotion of Knowledge of Materials of Engineering, and Standardization of Specifications and Methods of Testing"

TELEPHONE—RIttenhouse 6-5315 | R. E. Hess, Editor
R. J. Painter, Associate Editor | CABLE ADDRESS—TESTING

Number 144 | January 1947

Symposium on Paints and Paint Materials at Spring Meeting in Philadelphia

Two Symposium Sessions Scheduled for February 25; Headquarters Building Dedication on February 26; Committee Meetings All Week

THE 1947 A.S.T.M. Committee Week will include a large number of meetings of the various A.S.T.M. technical groups convening from Monday morning, February 24, through Friday, February 28, at the Benjamin Franklin Hotel in Philadelphia. During the week, on Tuesday, February 25, A.S.T.M. Committee D-1 on Paint, Varnish, Lacquer and Related Products, and the Philadelphia District Council jointly will sponsor the 1947 Symposium on Paints and Paint Materials, in which there will be eleven papers and addresses by some of the country's leading authorities. On Wednesday, February 26, there will take place the formal dedication of the Society's Headquarters on Philadelphia's Parkway, and in the evening the Dedication Dinner will be held at the Benjamin Franklin Hotel, preceded by a cocktail hour.

The first session of the Paint Symposium is scheduled to begin at 9:30 a.m. on Tuesday, with the afternoon session getting under way at 1:45 o'clock. The Dedication Dinner will start at 7 o'clock; the cocktail hour preceding, scheduled to begin at 6 p.m. at the hotel.

Notes on the Dinner:

All members of the Society are invited to attend the Dedication Dinner on Wednesday, February 26, and a return form by which dinner reservations can be made has been mailed to each member and committee member. It will be helpful to the Philadelphia District Council if reservations are made promptly accompanied by the remittance. This return form is part of the printed program that has been sent to the members.

Price of the dinner will be $5 which includes gratuities. Tickets for the cocktail hour can be procured in the Benjamin Franklin's ballroom foyer in the afternoon of February 26. A number of dignitaries will be present at the dinner, and some nationally prominent industrialist or engineering leader will give the main address.

Symposium on Paint

The Program Committee headed by Carlton H. Rose, National Lead Co., has virtually completed final arrangements for the sessions in this symposium and the program follows:

A.S.T.M. Symposium on Paint and Paint Materials

Hotel Benjamin Franklin, Philadelphia
Tuesday, February 25, 1947

Morning Session

Carlton Rose, National Lead Co., Presiding

Test Methods and the Paint Industry—John C. Moore, President, Federation of Paint and Varnish Production Clubs

Methods of Evaluation of Paints

C. C. Hipkins, Bell Telephone Laboratories, Inc., Presiding

Methods of Evaluation of Industrial Finishes—R. P. Pringle and E. M. Yacko, Bridgeport Works Laboratory, General Electric Co.

Methods of Evaluation of Automotive Finishes—Frederick Weed and Newell P. Beckwith, Rinshed-Mason Co.

Methods of Evaluation of Container Finishes—John H. McKenzie, American Can Co.

Methods of Evaluation of Marine Finishes—Allen L. Alexander, Office of Naval Research

Adjournment for Luncheon

Afternoon Session

Methods of Evaluation of Paint Materials

M. Van Loo, The Sherwin-Williams Co., Presiding

Particle Size by Gas Absorption—E. N. Harvey, Jr., Interchemical Corp., Research Laboratories

Inclined Tube Viscometer—Maynard Euverard, Interchemical Corp.

Stroboscopic Timer for Stormer Viscometer—E. P. Peterson and Joseph Prane, National Lead Co. Research Laboratories

Statistical Analysis of Paint Test Data

L. A. Melsheimer, American Cyanamid Co., Presiding

(over)

Last-Minute Dinner Notes

It is a pleasure to announce that Dr. E. U. Condon, Director, National Bureau of Standards, will give the principal address at the Dedication Dinner on the evening of February 26. Past-President T. G. Delbridge is to be the Toastmaster. President Arthur W. Carpenter will speak and there will be greetings from City of Philadelphia officials and the heads of certain educational and technical institutions in the city. The dinner will be a splendid opportunity for members to hear Dr. Condon who has been director at the Bureau for about a year.

Introduction to Statistics—A. E. R. Westman, Ontario Research Foundation, and Vice-Chairman of A.S.T.M. Committee E-11 on Quality Control of Materials

Application of Statistical Methods—E. I. Stearns, Calco Chemical Division, American Cyanamid Co.

Statistical Analysis of Test Data on Accelerated Weathering of Paint—Messrs. Roy Hill and George L. Cook, Engineer Board, Fort Belvoir, Va., and William E. Moyer, National Lead Co. Research Laboratories

As previously announced, the Program Committee was guided in its selection of topics by returns from a questionnaire distributed to many A.S.T.M. members in this field and from consultation with those concerned with paints and the evaluation of their properties.

All members of the Society and Committee Members, whether or not they are attending committee sessions during the week, are cordially invited to attend this outstanding symposium.

No preprints of the papers will be distributed, although the Program Committee plans to send to selected individuals sufficient material so that they can participate in the discussion.

Hotel Accommodations

It is believed that the long hoped-for time is now at hand when members need not worry about hotel accommodations. For the past several years it has been difficult to procure sufficient sleeping room accommodations in connection with national meetings, but the Benjamin Franklin, the headquarters hotel, has set aside a large block of rooms for A.S.T.M. use and in case these are not adequate, working arrangements have been set up with several other leading Philadelphia hotels to meet fully all requirements. A hotel return card addressed to the Benjamin Franklin should have been received by each member and committee member, and it is assumed that he will have sent in his reservations well in advance of the meetings.

In case members wish to stay at some specific hotel in the city it is suggested they write directly to that hotel.

A.S.T.M. Committee Week

The schedule of committee meetings to be held during A.S.T.M. Committee Week beginning February 24 in Philadelphia is designed to eliminate as many conflicts for the members as possible, but with so many meetings, obviously all conflicts cannot be prevented, particularly if an individual is a member of several groups. Nevertheless this system, in use for many years, of having many of the technical committees concentrate their meetings during one week does save a great amount of time and expense for the committee members. The schedule which has been mailed to all members of the Society and those serving on committees is not necessarily a final one, and the members should consider that the notices which are sent out by each of the committee secretaries should be the "last word." There will be a final schedule available at the A.S.T.M. Registration Desk on the mezzanine floor of the Hotel Benjamin Franklin, which schedule will include the room assignments.

The following schedule notes only the meetings of the main committees. There are usually a large number of subcommittees of these groups convening prior to the main committee meetings.

Committee Week

Monday, February 24 to Friday, February 28, incl.

A-1 on Steel, *Wednesday*, 10:30 a.m.

A-7 on Malleable-Iron Castings, *Friday*, 9:30 a.m.

B-3 on Corrosion of Non-Ferrous Metals and Alloys, *Wednesday*, 3:00 p.m.

B-4 on Electrical Heating, Resistance and Related Alloys, *Thursday*, 4:00 p.m.

B-5 on Copper and Copper Alloys, Cast and Wrought, *Friday*, 9:00 a.m.

B-6 on Die-Cast Metals and Alloys, *Wednesday*, 9:00 a.m.

B-8 on Electrodeposited Metallic Coatings, *Friday*, 9:00 a.m.

C-7 on Lime, *Tuesday*, 2:00 p.m.

C-16 on Thermal Insulating Material, *Wednesday*, 3:00 p. m.

C-17 on Asbestos—Cement Products, *Friday*, 10:30 a. m.

D-1 on Paint, Varnish, Lacquer and Related Products, *Wednesday*, 2:00 p.m.

D-5 on Coal and Coke, *Tuesday*, 2:00 p.m.

D-8 on Bituminous Waterproofing and Roofing Materials, *Thursday*, 3:00 p.m.

D-9 on Electrical Insulating Materials, *Friday*, 3:00 p.m.

D-11 on Rubber and Rubber-Like Materials, *Thursday*, 3:30 p.m.

D-12 on Soaps and Other Detergents, *Tuesday*, 2:00 p.m.

D-19 on Water for Industrial Uses, *Thursday*, 9:30 a.m. and *Friday*, 9:30 a.m.

E-9 on Fatigue, *Thursday*, 9:30 a.m.

E-11 on Quality Control of Materials, *Tuesday*, 9:00 a.m.

Part of Logan Circle and the Franklin Institute (east) Across from the A.S.T.M. Headquarters Building.

New Specifications and Tests Approved

Standards Committee Acts on Proposals Covering Corrosion-Resistant Castings, Oils, Adhesives, Glass Fabrics and Compression Testing

FROM THE accompanying table it will be noted that the Society has recently approved seven new tentative specifications and test methods, and accepted revisions in two other existing standards. The dates on which the Administrative Committee on Standards, acting for the Society, approved the respective items are given. In the remainder of this article there are some notes on the various items and a listing of the technical committees responsible for each of the recommendations.

Each of these new and revised tentatives will appear in the 1946 Book of Standards in the respective parts covering the family of materials indicated.

Corrosion-Resistant and Heat-Resistant Castings:

The two new tentative specifications for corrosion-resistant (A 296) and heat-resistant (A 297) iron-chromium-nickel alloy castings for general applications were developed in the Subcommittee on Castings of A.S.T.M. Technical Committee A-10. The grades covered in the specification for heat-resistant castings are general purpose alloys, and the committee points out that no attempt is made to include heat-resistant alloys for special product applications, such, for example, as are covered in other A.S.T.M. standards for castings for use at elevated temperatures developed in Committee A-1 on Steel, or for the alloy castings of the 25-12 class which are intended for structural elements, containers, etc., in electric furnaces and related applications as developed in Committee B-4. Some ten heat-resistant grades are covered, with chromium content ranging from 12 to 29 per cent, and nickel in the respective alloys varying from a low of a nominal 9 per cent to 66 per cent.

The twelve grades covered in the specification for materials for corrosion-resistant service are indicated as suitable for broad ranges of applications and for a variety of services.

Foaming Characteristics of Crankcase Oils:

This new method (D 892) developed in Committee D-2 on Petroleum Products and Lubricants is intended primarily to determine whether an oil will foam at specified temperatures. The method sets forth means of rating empirically the foaming tendency and stability and details the apparatus required. An outline of the method indicates that the sample, maintained at a temperature of 75 F. is blown with air at a constant rate for 5 min., then allowed to settle for 10 min. The volume of foam is measured at the end of both periods. The test is repeated on a second sample at 200 F., and then, after collapsing the foam, at 75 F.

Varnished Glass Fabrics:

These new methods (D 902) developed in Committee D-9 on Electrical Insulating Materials essentially combine into one document all of the methods developed in A.S.T.M. work for evaluating glass fabrics. To effectuate this some of the procedures formerly covered in the methods of testing varnished cloths and cloth tapes (D 295) are now covered in the newer methods.

Permanence and Stripping Strength of Adhesives:

The two new tests in this field, one covering the peel or stripping strength of adhesives (D 903), the other a recommended practice for determining effect of light on the permanence of adhesives (D 904), have resulted from intensive work in Committee D-14. The method for stripping strength is intended for use in determining these characteristics when the material is tested on standard size specimens and under defined conditions of pretreatment, temperature, and testing machine speed.

The method further incorporates certain definitions necessary in an understanding of the procedure, as follows: (*a*) peel or stripping strength is the average load per unit width of bond line required to progressively separate one member from the other over the adhered surfaces at a separation angle of approximately 180 deg. and at a separation rate of 6 in. per min., it is expressed in lb. per in. of width; (*b*) in order to fulfill all terms of the definition, at least one of the adhered materials must be flexible; the designation "flexible" shall in this instance indicate a material of the proper flexural strength and thickness to permit a turn back at an approximate 180 deg. angle in the expected loading range of the test without failure.

(*over*)

Actions by the A.S.T.M. Administrative Committee on Standards December, 1946

New Tentatives

Specifications for:
- Corrosion-Resistant Iron-Chromium and Iron-Chromium-Nickel Alloy Castings for General Application (A 296 – 46 T).
- Heat-Resistant Iron-Chromium and Iron-Chromium-Nickel Alloy Castings for General Application (A 297 – 46 T).

Methods of:
- Test for Foaming Characteristics of Crankcase Oils (D 892 – 46 T).
- Testing Varnished Glass Fabrics and Varnished Glass Fabric Tapes (D 902 – 46 T).
- Test for Peel or Stripping Strength of Adhesives (D 903 – 46 T).
- Determination of the pH of Aqueous Solutions with the Glass Electrode (E 70 – 46 T).

Recommended Practice for:
- Determining the Effect of Artificial (Carbon-Arc Type) and Natural Light on the Permanence of Adhesives (D 904 – 46 T).

Revision of Tentatives

Specifications for:
- Carbon-Chromium Ball and Roller-Bearing Steels (A 295 – 46 T).
- A.S.T.M. Thermometers (E 1 – 46 T).

Method of:
- End-Quench Test for Hardenability of Steel (A 255 – 46 T).
- Compression Testing of Metallic Materials (E 9 – 46 T).

The recommended practice on effect of light (D 904) is intended to define conditions for the exposure of adhesives in the form of glued transparent or translucent assemblies to (1) artificial and (2) natural light sources. Where such information is of value, the same exposure conditions may be used on adhesive film or any other suitable form in which light may be a deteriorating factor. This recommended practice is limited to the method of obtaining the exposure conditions and procedure to be followed, but does not cover methods of test to be used in evaluating the effects of the exposure.

pH; Compression Testing of Metals; Thermometers:

The method for determining pH of aqueous solutions with the glass electrode (E 70) was developed in the Technical Committee on Hydrogen Ion Determinations functioning under Committee E-1 on Methods of Testing. The published method details scope, briefs certain definitions, and covers the standard buffer solutions, apparatus to be used, standardizing the assemblies and determining the pH values.

Revised methods of compression testing of metallic materials (E 9) bring the requirements up to date and include the use of a subpress which is detailed in the method.

The revised tentative specifications for thermometers (E 1–46 T) include a number of general modifications but also include several new thermometers. The general requirements indicate certain types of marking which are preferred, typographic style to be followed, etc. The new thermometers cover uses in gas calorimetry, kinematic viscosity thermometers for work in petroleum, and also a congealing point thermometer.

End Quench Hardenability Test; Bearing Steels:

Two subcommittees functioning in Committee A-1 on Steel are responsible for the revised methods for end quench testing for determining hardenability of steel (A 255), and also for the revised tentative specifications for bearing steels (A 295). The primary objective in the hardenability test is to bring the description of the procedure and the details to be followed more nearly in line with the S.A.E. recommended practice. There is no change in the chart which is part of the methods A 255; merely in the text. Such details as temperature of the water in the quenching stream, time of removing specimen from the furnace and beginning the quench, and the use of the method when definite limits on the values are set up, are covered.

The revised tentative specifications for bearing steels essentially bring these up to date, with the more extensive changes involving the methods of testing. More precise requirements are given with respect to fracture, macroetch and inclusion rating, and the section on microstructure and hardness has been clarified. The three grades previously covered in this specification when it was an emergency document (Es 5a) are continued, namely, the 52100, 51100, and 50100 steels. Major differences in chemistry, of course, involve chromium, with the respective ranges being 1.30–1.60, 0.90–1.15, and 0.40–0.60 per cent.

Plastics Committee Plans Interesting Technical Symposium in Cincinnati March 4 and 5

An interesting and quite extensive Symposium on Plastics will be held in Cincinnati, Ohio, on March 4 and 5, during the series of committee meetings which are being arranged at that time by A.S.T.M. Committee D-20 on Plastics. A symposium committee has been at work for some time, and plans for two technical sessions. All those concerned with the subject of plastics are cordially invited to attend these sessions at the Netherland-Plaza Hotel, the first of which will be on the evening of Tuesday, March 4, with the second session on the afternoon of March 5.

A. W. Downes, Jr., Carbide & Carbon Chemicals Corp., is chairman of the symposium committee, and he has enlisted the active cooperation of a number of leaders in the industry.

A most important part of the symposium will be the paper by Dr. M. M. Braidech, Director of Research, Fire Underwriters' Laboratories, who will cover fire hazards with respect to plastics. There is intense interest in this whole subject of combustion and flammability, and in the plastics and many other industries technical men are actively at work developing test procedures to determine fire hazards, etc. The program follows:

SYMPOSIUM ON PLASTICS

A.S.T.M. Committee D-20 on Plastics
Netherlands Plaza Hotel
Cincinnati, Ohio

Tuesday Evening March 4, 1947, 8 o'clock

Permanence of Plastics—G. M. Kline, Chief, Organic Plastics Section, National Bureau of Standards

Flammability of Plastics—M. M. Braidech, Director of Research National Board of Fire Underwriters

The Electrical Properties of Plastics—A. J. Warner, Supervisor Engineer, Federal Telecommunications Laboratories

The Effects of Fungus and Moisture on Plastics—J. Leutritz, Jr., Member Technical Staff, Bell Telephone Laboratories, Inc.

Wednesday Afternoon March 5, 1947, 1:30 o'clock

Low Pressure Phenolic Laminates—T. W. Noble, Manager, Plastics Division, Fabricon Products Corp.

The Mechanism of Plasticization in Plastics—J. K. Craver, Divisional Development Department, Monsanto Chemical Co.

Use of Plastic Materials in Optics—H. R. Moulton, Assistant Director of Research, American Optical Co.

Metal-Plastic Applications—R. G. Chollar, In charge Plastics Laboratory, National Cash Register Co.

Automotive Glazing with Plastics—J. D. Ryan, Assistant Director of Research, Libbey-Owens-Ford Glass Co.

Progress in Rubber

By Arthur W. Carpenter[1]

Editor's Note.—This address by President Carpenter was given at meetings sponsored by the Cleveland and the Pittsburgh A.S.T.M. Districts on November 7 and December 2, respectively, and as this BULLETIN nears press it is being presented at a meeting under the auspices of the Chicago District and the Chemical and Metallurgical Section of the Western Society of Engineers on January 7. Mr. Carpenter's purpose was not to give a highly technical discourse on some special chemical or physical phases of rubber, but rather to bring out certain interesting features of the rubber field and the industry with which he has been so closely associated for many years, that would be of interest to any engineer and technologist, no matter what his calling. We believe he has succeeded admirably in this objective and that this paper will prove interesting and profitable reading for all our members and those who get the BULLETIN.

IN DISCUSSING the subject of progress in rubber at District Meetings of the American Society for Testing Materials it would doubtless be appropriate to describe the contributions which have been made by the A.S.T.M. Committee D-11 on Rubber and Rubber-Like Materials and their products. Such a presentation would certainly demonstrate how well the purpose of the Society has been carried out in the promotion of knowledge of the materials of engineering and the standardization of specifications and methods of test. It would be necessary to tell about the "spade work" done by that earnest group of producers and consumers who labored diligently during the years from 1912 to 1928 in order to bring into existence standard specifications for a number of important rubber products, particularly those used by the railroads. Test methods were not too well developed and the different laboratories frequently had great difficulty in checking results obtained on the same products. In consequence, some of the specifications were not very satisfactory and were withdrawn when the committee decided to concentrate on test methods. Following this change in objective, the work of the committee progressed rapidly, and in 1935, the first compilation of A.S.T.M. Standards on Rubber Products was published containing many new methods of test as well as the best of the revised specifications. This book, which now appears annually, has grown to a substantial volume of more than 500 pages and has become the standard test manual in most rubber laboratories.

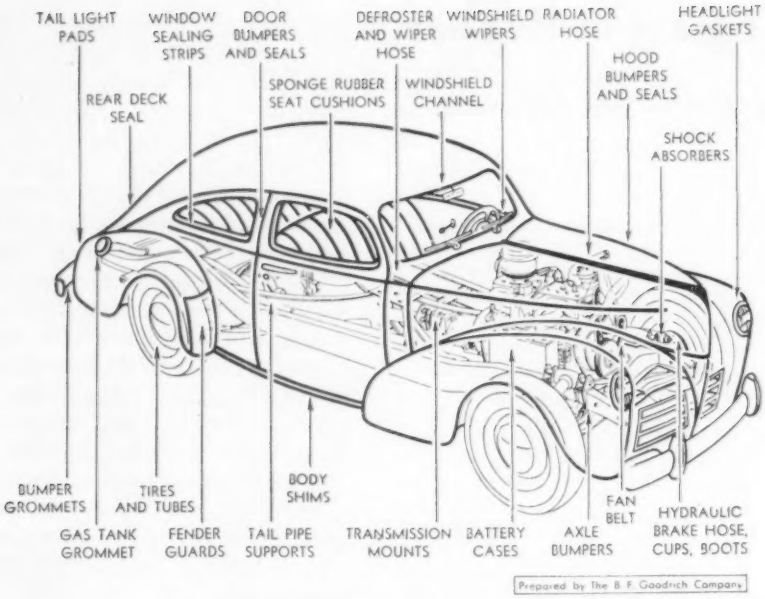
[1] President of A.S.T.M., and Manager of Testing Labs., The B. F. Goodrich Co., Akron, Ohio.

WORK OF COMMITTEE D-11

The activities of Committee D-11 could not be adequately presented without detailing the splendid work done in more than twenty subcommittees and in its Technical Committee A on Automotive Rubber. The latter was organized in 1938 as a joint committee with the Society of Automotive Engineers. For years prior to this, many automotive engineers seemed to consider rubber technologists an uncooperative secretive race who deliberately withheld valuable engineering information for commercial reasons. These automotive people were vocal in their complaints and pointed out that they did not think rubber technology differed so greatly from metallurgy. Both classes of materials have their properties profoundly changed by admixtures as in compounding of rubber or alloying of metals and both are subjected for various reasons to heat treatment which in the case of rubber is called vulcanization. These complaints finally led to the suggestion of a joint committee. Working together closely in monthly meetings, these groups speedily reached a mutual understanding of viewpoints and within three years wiped out all feeling of distrust, improved the methods of testing automotive rubber, and developed a system of tables for identification and classification of rubber compounds for automotive use which now has an important place in the specifications of the leading automobile companies. During the war years, these tables furnished a pattern and basis for specifications extensively used by the Ordnance departments of both the Army and Navy, whose representatives were added to the membership of the committee. Also, with the committee ready and active in the rubber field, it was inevitable that many pressing war problems dealing with rubber should be referred to it either directly by the armed forces or through the Ordnance Advisory Committee. In recognition of its service, A.S.T.M.-S.A.E. Technical Committee A had conferred upon it at the conclusion of hostilities, the Naval Ordnance Development Award—a splendid tribute to the results of cooperative standardization work. The committee is not through but is now meeting at bi-monthly intervals and has again turned its attention to the needs of peacetime industry. Much can be expected of it in the future.

IMPORTANCE OF RUBBER

Instead of expanding the interesting story of the A.S.T.M. work in rubber, it has seemed more desirable under the conditions which exist today to direct this discussion into the broader field of progress in the rubber industry as a whole. Within the memory of many of us, rubber has become a material of vital importance in the national economy, essential for transportation, communications, and the maintenance of our health and well-being both in peace and in war. Automobiles, trucks, busses, bicycles, and agricultural machines all travel on rubber tires. The modern automobile alone uses rubber in approximately 265 places to give greater comfort

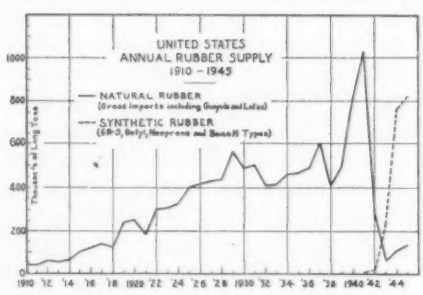


Some Rubber Applications in an Automobile.

and longer service. Airplanes depend not only on tires and tubes for safe landing but also on de-icers for safe flying under adverse conditions and on hydraulic control hose and many other rubber parts which are required for their proper operation. Insulation made from rubber or rubber-like materials guards our power, telegraph, and telephone lines. Rubber foot-wear and clothing, hot water bottles, and countless medical supplies protect our health. Various styles of hoses and belts convey materials of all kinds and transmit power. Vibrations and noises are quieted, our rides made smoother, and our beds more comfortable by use of this magic material. The recent war with its shortages has demonstrated beyond question that an adequate supply of rubber is a necessity.

Natural Rubber:

Just before the war, in the year ending March 31, 1941, the United States consumed 684,000 long tons of natural rubber of which approximately 70 per cent went into tires and tubes. This was a long way from the time when Dr. Benjamin Franklin Goodrich established his small rubber factory in Akron, Ohio, in 1870. That year the total consumption in the nation was less than 4000 tons. The rubber he used was obtained from wild trees in the jungles of tropical America and it was scarce and expensive. Commercial development had not progressed greatly, either in the production of the raw material or the manufacture from it of useful articles since the discovery, 31 years before, of the process of vulcanization with sulfur and heat. A few years later, in 1876, rubber seeds were taken from Brazil to England and furnished the starting point for the rubber plantation industry. The seeds were planted in Kew Gardens and the little seedlings were eventually transplanted in Ceylon, but it was not until about 1900 that the first commercial plantations came into production. The quantity produced was so small that it hardly counted at all in the 20,000 tons of natural rubber imported into the United States that year. By 1910, the plantations were able to account for about 7000 tons out of a total production of 80,000 tons. That year represented the peak of wild rubber production, which was not exceeded even under all of the stimulation, financial and

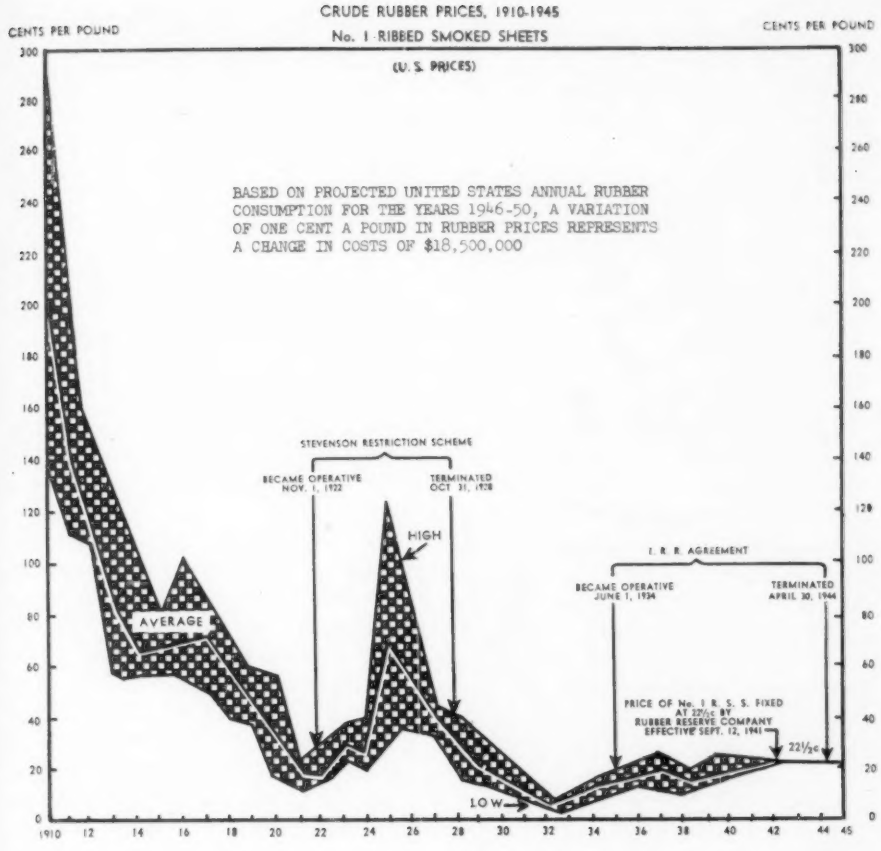


otherwise, during the recent World War. During this period the price of the crude rubber generally trended upward as demand from the growing industry pressed upon the supply until in 1910 the average cost to the manufacturer was over $2 per pound with a range from a low of $1.41 to an all-time high of $3.12.

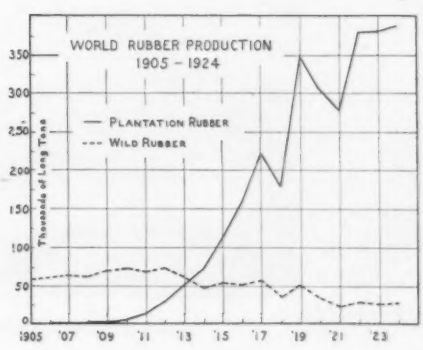
After 1910, the whole picture changed. Within four years, production of plantation rubber equaled that of wild rubber and continued to expand under the stimulus of the enormous growth of the automotive industry which increased U.S. imports to nearly 250,000 tons in 1920. Use of wild rubber steadily decreased but the use of plantation rubber increased until in 1940 the total world production was about 1,400,000 long tons, of which the United States consumed 46 per cent. Rubber was then our largest single import, and 97 per cent of our supply came from plantations in the Far East. The stock of rubber actually on hand in this country in June of 1940 was only 168,000 tons or about 3½ months supply. With increasing production of plantation rubber, prices fell very rapidly at first but were subject to some rather violent fluctuations during the years of the first World War depending on the relation of supply to demand. By 1921, a low of 11½ cents was reached, which gave rise to the Stevenson restriction scheme for reducing production and controlling price. In the face of a growing demand, this resulted in a scarcity and in 1925, rubber prices hit another peak of $1.23 per pound. The plan was abandoned in 1928 and with the coming of the depression years, rubber reached a low of 2⅝ cents per pound in 1932. This led to another regulatory plan, agreed upon internationally among the rubber producers, which stabilized the price on averages around 15 to 20 cents and which was still in effect when the treacherous attack of the Japanese at Pearl Harbor plunged this nation into the second World War and shortly cut us off from our principal rubber supplies.

American Rubbers:

It was fortunate indeed for our continuance as a free nation that the results of many years of scienti-


CRUDE RUBBER PRICES, 1910-1945
No. 1 RIBBED SMOKED SHEETS
(U. S. PRICES)
CENTS PER POUND
BASED ON PROJECTED UNITED STATES ANNUAL RUBBER CONSUMPTION FOR THE YEARS 1946-50, A VARIATION OF ONE CENT A POUND IN RUBBER PRICES REPRESENTS A CHANGE IN COSTS OF $18,500,000
STEVENSON RESTRICTION SCHEME
BECAME OPERATIVE NOV. 1, 1922
TERMINATED OCT. 31, 1928
HIGH
AVERAGE
LOW
I. R. R. AGREEMENT
BECAME OPERATIVE JUNE 1, 1934
TERMINATED APRIL 30, 1944
PRICE OF No. 1 R. S. S. FIXED AT 22½c BY RUBBER RESERVE COMPANY EFFECTIVE SEPT. 12, 1941
22½c

fic research on synthetic rubbers had been brought during the decade preceding this disastrous event to a point where plant scale production was possible. Our greatest military leaders have said that without the marvelous accomplishments in manufacture and utilization of synthetic rubbers the war could not have been won. During the first World War, the Germans had turned to man-made rubber when cut off from natural sources by the British blockade of the seas, but the attempt to use polydimethyl butadiene had very slight success even in the day of limited use of automotive transport and a different type of warfare. This failure however led them to further research resulting eventually in the Buna rubbers. In this country, the peak prices of 1925 and the natural curiosity of scientists to know more about the nature of rubber provided a powerful urge in research which culminated in the development in the early thirties of neoprene and thiokol. These first American rubbers proved very valuable for special purposes such as oil resistance but were too expensive and not well suited for general use. In 1926, the B. F. Goodrich Co. started intensive work on the development of synthetic rubber-like materials. Dr. Waldo Semon and his associates in this program had not only to investigate the possibilities for rubber-like polymers but also, in many cases, were obliged to develop the raw materials, including practical processes for their production and purification. From this work came many interesting and valuable products, including the well-known plastic Koroseal. Finally, promising new butadiene-type synthetic rubbers were obtained, and in 1937 a pilot plant was built for their production on a semi-commercial scale.



Rubber and the War

In the opinion of Mr. John L. Collyer, President of the B. F. Goodrich Co., this work on American rubber was of utmost urgency. After many years of experience abroad, he was fully aware of the objectives of Germany and Japan. The low stocks of rubber in the country and the danger of interference in the long supply line to the Far East created hazards which, in his opinion, could not be tolerated. He knew that time would be required for expansion of the infant synthetic industry and with the outbreak of the war in 1939, the time was growing short. Two-fold action was necessary. The low rubber stocks on hand would have to be increased by stock-piling to provide a bank until large-scale production of American rubber could be realized, and this production expansion would have to be pushed with all possible speed to provide insurance of security. Government sponsorship of this program would be necessary because the required plant investment for production of the raw materials and the final rubber was too great for any one company to assume. Also, the cost of the synthetic rubber as produced on pilot-plant scale was too high for immediate commercial competition, although careful studies had indicated good possibilities for ultimate cost reduction to practical levels. The public, however, was apathetic and government interest was hard to arouse in the face of British assurances of adequate protection of our rubber supply. However, about the middle of 1939, growing military concern over strategic rubber requirements led to an agreement between America and Britain for exchange of approximately 90,000 tons of rubber for a half million bales of cotton. Somewhat later, the Rubber Reserve Co. was created with authority to negotiate larger purchases.

On June 5, 1940, The B. F. Goodrich Co. introduced for sale an automobile tire in which American rubber produced in its own plant replaced natural rubber by more than 50 per cent. Besides providing additional experience in the practical utilization of synthetic rubber,

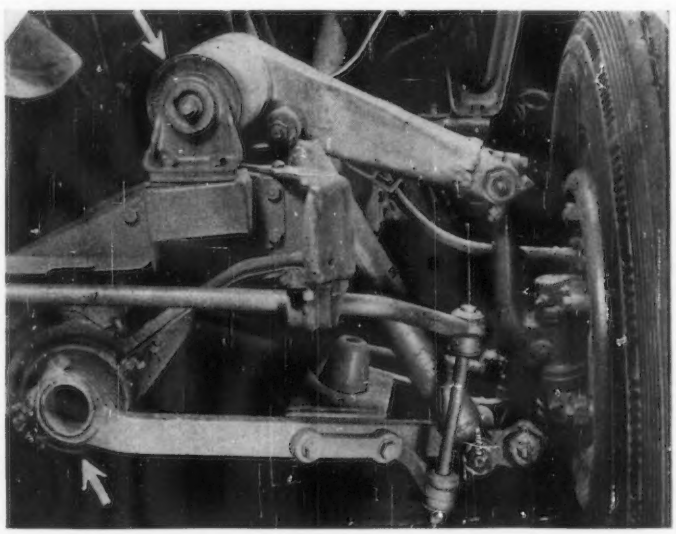
the production of this tire vividly drew national attention to the critical rubber problem. Arrangements shortly followed for larger Government purchases of natural rubber, but positive action was not taken at once on Mr. Collyer's recommendation made in July, 1940, urging erection of two or more 36,000 ton-per-year Government-owned plants for production of synthetic rubber. In 1941, only about 8000 tons of American-made rubber were produced, and this was all from privately owned plants. However, constant effort and repeated recommendations anticipating subsequent events were beginning to take effect and by the time of Pearl Harbor, arrangements had been made for the construction of plants to the extent of 40,000 tons annual capacity. Within the next month, this was increased to 400,000 tons and by mid-summer to about 800,000 tons. The figure ultimately reached 1,100,000 tons per year.

Much valuable time had been lost and the necessary plants had to be built in the midst of many competing demands for materials of construction and critical components badly needed for other urgent war programs. The total natural rubber stocks in both Government and private industry's hands, which had reached about 633,000 tons by the end of 1941, amounted to less than one normal year's supply but had to be extended to cover all essential needs both military and civilian, until the new American plants could be completed and the techniques of successful operation and utilization of their product could be acquired. Obviously, most rigid conservation was necessary and, at best, it was a race against time. In the 3½ years after January, 1942, to VJ-day, total natural rubber imports from all sources outside of enemy-occupied countries added only about 300,000 tons to our stock. Truly the task which confronted the rubber industry was a formidable one. It is interesting to know that when Government investigators went through the records of the great I.G. Co. of Germany after the war, they found reports from technical experts to high officials assuring them that the American rubber program which was planned was impossible of accomplishment. Fortunately, the result is now history and the program was accomplished.

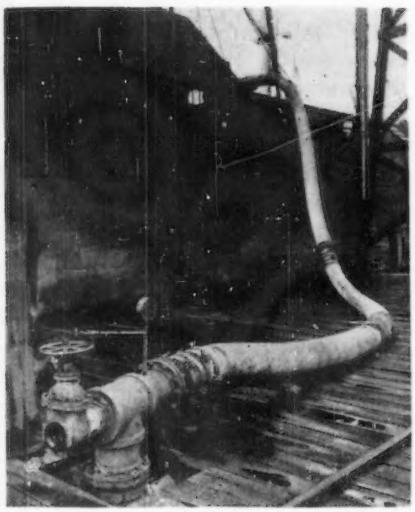
By the end of 1944, the American synthetic industry was operating at the rate of more than 1,000,000 tons per year. In 1945, consumption of rubber in the United States amounted to about 800,000 tons of which 87 per cent was made in America and, in addition, substantial quantities of American rubber were furnished to our Allies. During 1946, our consumption exceeded one million tons and present estimates indicate only slightly less for 1947. The output of rubber products in the U. S. is also at the highest level in history. Present indications are that the industry tire production in the past year exceeded that of 1940 by more than 40 per cent, reaching a total in excess of 80,000,000 units of which more than 65,000,000 were passenger car tires.

Natural *versus* Synthetic Rubbers

This high production level with American rubber has been attained within the short space of three years and in spite of the early difficulties when its quality was variable and more time and labor were required for its processing. Better control in the synthetic plants, development of improved polymers and processes, more rigid specifications covering all operations from the raw materials to the finished product, infinite attention to all details of manufacture, and, above all, research and improvement of techniques have contributed to this accomplishment. It can now be stated with certainty that for the majority of purposes American rubber is as satisfactory as the natural material if full advantage is taken of the improved techniques and engineering knowledge which have been developed. In some applications, certain types are superior. As yet, there are some inherent limitations in the large volume general purpose synthetic which necessitate the use of natural rubber in services where these limitations are important factors. These include somewhat less resilience and greater hysteresis characteristics which result in more heat generation in repeated flexing; also, low strength, unless compounded with substantial proportions of carbon black in which case the hardness of the cured rubber is greater for equivalent strengths than with natural rubber. Aging and wear resistance are generally superior. Synthetic rubber alone has not proved successful in large truck and bus tires, primarily because of the heat generation, but, since the smaller sizes of tires for passenger cars are not subject to the same service conditions, the present-day synthetic tire as designed for this service by leading manufacturers is definitely superior to the pre-war natural rubber tire. American rubber compounds used as



Rubber Spring Suspension of an Automobile.



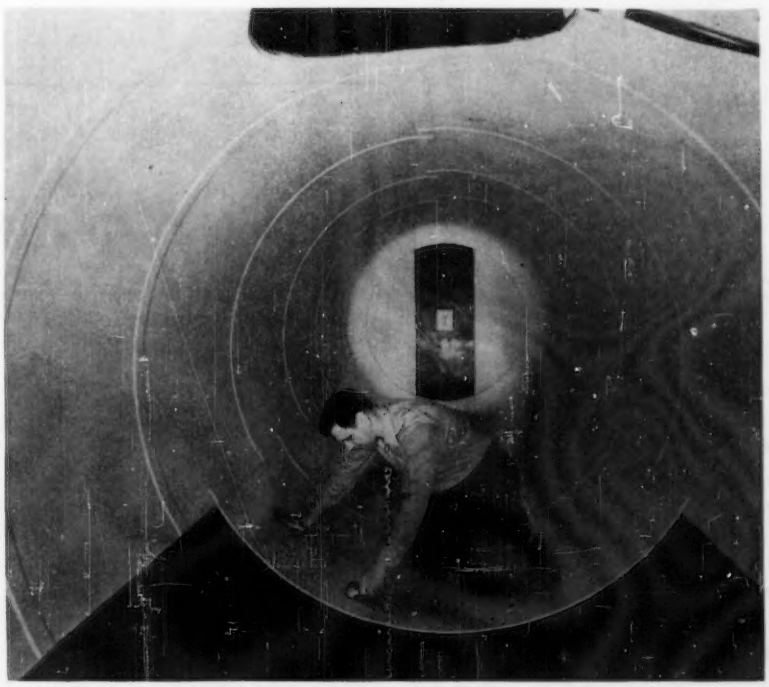
Fuel Oil Hose Made of Synthetic Rubber.

insulation in some types of electrical wires and cables have been found to give better aging and performance characteristics than natural rubber, but the latter is better in certain types of springs and vibration dampers because of greater resilience and lower hysteresis effects. Pure gum stocks of the type used in rubber bands and thread are not satisfactory when made from general purpose synthetic because of the compounding required for the necessary strength. However, much has already been done in developing special purpose rubbers where particular limitations are controlled or eliminated, and there is every reason to believe that continued research may even bring forth new general purpose rubbers which will surpass any now known, including the natural material.

Special purpose rubbers particularly are widely used in cases where resistance to oils, solvents, and oxidation are required. Fuel oil hose, hydraulic brake hose, gasoline hose, airplane hydraulic control system hoses, many types of tank linings and gaskets are examples in which natural rubber is not successful but where special purpose synthetics give superior service. Surface protection of airplane de-icers against the action of sunlight, oxygen, and ozone is another example of fitting the rubber to the job. Butyl rubber with its superior resistance to permeability of gases has proven to be a most successful material for inner tubes. Many other examples might be mentioned, but enough has been said to indicate that whereas rubber technologists were formerly limited to use of two rubber materials, namely crude rubber and reclaimed rubber,—and where these would not work there was not much that could be done,—they now have a whole range of new rubber-like materials with a variety of different properties from which to choose. At least six special rubbers are in regular production, and many more have been made. Most of these may be blended and in many cases modified to meet specific needs. Further research will undoubtedly extend the field.

Rubber in Peacetime

In creating the facilities for American rubber, as a war measure more than $700,000,000 was expended by the Government. The World War is behind us and we now face the tremendous problems of the peace. Natural rubber is returning to the world markets in an ever-increasing flood. Production in the former Japanese-occupied areas is exceeding all estimates and together with that of Ceylon will probably amount to 600,000 tons in 1946 and nearly a million tons in 1947. Within the past three months the Rubber Reserve Co. has concluded agreements with the British and the Dutch for purchase of 200,000 tons at a delivered price of 22½ cents per pound. With previous purchases at 25¾ cents per pound, the new agreements guaranteed receipt in the United States of over 500,000 tons of natural rubber during 1946. The International Combined Rubber Committee was terminated on December 31 and international trade reverted to a free market. Within the United States, control will probably be continued at least until the expiration on March 31, 1947, of the Second War Powers Act under which all Government purchases and allocations of rubber are made possible. Restrictions on the use of natural rubber are being rapidly eased. The last of October permissible natural rubber content of small passenger tires was raised from 13 to 23 per cent, on larger tires from 13 to 67 per cent, and on large truck, bus, and special-purpose tires restrictions were entirely removed. The world is rapidly again approaching a condition of tremendous overproduction of rubber such as resulted in the 2⅝ cent price of 1932 except that this time the situation will involve a potential natural rubber supply of possibly 1,600,000 tons and 1,400,000 tons of synthetic materials with a possible world



Rubber Lining a Tank for Chemical Resistance.

requirement of about one half the combined amounts. The present selling price established by the Government for the general purpose American rubber, GR-S, is 18½ cents per pound which maintains proper price structures on end products with the current natural rubber price of 22½ cents. In the combination of copolymer, butadiene, and styrene plants representing the lowest operating costs, American rubber has been produced at approximately 11 cents per pound. It is of course possible that continued research may result in further cost reduction, but in the present state of knowledge it appears that under a free economy the selling price of American rubber might stabilize at approximately 15 cents per pound. Some estimates of ultimate plantation rubber costs visualize profitable operation at selling prices as low as 8 cents per pound. Without control, this situation economically could destroy the synthetic industry except for the relatively small production of special purpose rubbers which could always command a premium price. Certain basic facts must be faced now and a wise, far-sighted policy adopted at once.

These problems have been studied extensively by the Government Inter-Agency Policy Committee on Rubber headed by William L. Batt. Many recommendations have been made this past year to Congress and to the President concerning the future use and disposition of the synthetic industry and the Government peacetime program for rubber. Briefly, these include continuous maintenance in production and use of about 250,000 tons per year of our present general-purpose synthetic capacity regardless of cost, together with maintenance by the Government, out of operation but in adequate stand-by condition, of additional capacity to provide a total of about 600,000 tons by resumption of operation in the event of another national emergency. This will require special legislation involving some plan of Government subsidy, guarantees, protection or support but represents the minimum which is considered absolutely essential for the national security. In addition, the Government should accumulate and maintain an adequate stockpile of natural rubber for strategic purposes and critical uses. We must never again be in the same position as at the time of Pearl Harbor, for there might not be opportunity to carry out another such program as has been described. Private ownership and operation of the synthetic industry should be a major objective in order to stimulate research and development and to produce competitive conditions leading to quality improvement and cost reductions. Broad research programs in both the synthetic and domestic natural rubber fields should be supported both by Government and private industry. Ultimate survival of the portion of the new synthetic industry outside of that required for national security will depend on economic and technical progress. Only by the unrestricted play of economic forces will consumers be supplied with the highest quality of rubber products at the lowest economical costs.

The recommendations of the Batt committee are substantially the same as those in the postwar rubber program proposed by Mr. Collyer over a year ago and will certainly have the support of the rubber industry. In order that they may be carried out promptly however, and that the confusion and indecision of previous experience in the formation of rubber policies may be avoided, it is essential that the next Congress shall take action in the very near future. The problems are squarely before us and the vigorous support of such action by an informed and aroused public is urgently needed.

What the Consumer Wants in Standardization

A Condensation of a Talk Given by Mrs. Guy Moffett[1] Before the Annual Meeting of the American Standards Association on November 21, 1946

ABOUT TWO-THIRDS of the gross national production for 1947 of $182 billion, according to Department of Commerce estimates, will be for consumer expenditures. A large part of this $120 billion will be spent by women. From this fact stems their interest in consumer goods standards. They think of them as definitions of what goods and services are, and what they will do for them. Without such definitions, they have the uncomfortable status of gamblers with the family's resources.

Awareness of the element of gambling in consumer purchases has been greatly intensified by the war. Surprisingly, shortages and high prices have proved less irritating to individuals than the exasperating uncertainty about the performance they could expect from the things they had to buy. The waste of money on things which proved unsatisfactory or practically worthless has been obvious enough to create a broader demand for standards than ever existed before.

[1] Mrs. Moffett is a member of the Board of Directors of the American Standards Association representing the American Association of University Women and American Home Economics Association.

The kind of standardization we want as ultimate consumers is that which answers the questions in our minds when we shop. We can discuss standards for consumer goods by considering what these questions are and how we would like to have them answered.

The most obvious question, is how much are we getting at a given price?

This is answered by our standards for weights and measures. Despite common acceptance of the principles embodied in these standards, we do not let them serve us well. Many products are priced by the package or can. Net contents must be printed on containers, but few of us care to take the time when we shop to reduce that price to so much an ounce, to determine which may be the best buy. We need standards for containers to reduce the number of sizes, with a view to relieving confusion and preventing deception.

Another question we want answered is, how safe is it?

The things we buy obviously should not be bad for our health or endanger our lives, and the conditions under which we use them should be made as safe as possible.

It is almost a truism that when voluntary standardization is postponed too long after the need for it arises, it becomes a political question. Such a situation has arisen concerning the inflammability of fabrics. When little boys were burned to death because the imitation sheepskin, made of highly napped rayon, on their cowboy suits ignited as they stood before a bonfire, Congressmen burst into that familiar chant, "there ought to be a law." Slippery bath tubs without handgrips, unsafe household ladder-stools, highly inflammable blanket materials, slippery floor finishes, all add to the yearly toll of fatal accidents. We need safety standards for homes and consumer goods.

A third big question for us all is, what is the size and fit?

We have almost forgotten the time when we had to shop around to find an automobile tire which would fit the rim of our particular car. But when it comes to the much more important consumer need—that for clothing—we have made little progress.

We know such standards are possible. The United States Bureau of Human Nutrition and Home Economics has demonstrated how to find out what body dimensions are, and classify them according to the frequency with which they occur. In 1937, it measured 147,000 children. The results of this study revealed that *age*, the prevalent method of size designation, is the poorest indicator of a child's size; height and girth of hip, the best basis for standards of size and fit. A trade standard has been developed which is somewhat less than the best that could have been adopted, but an improvement upon the unsatisfactory age classification. It is slowly coming into use.

But similar chaos persists in sizing women's clothing, and to a lesser extent in men's. It is costing both retailers and consumers huge sums every year for alterations. Women today often must pay from a fourth to a third more than the cost of a garment for alterations before it can be worn. This useless waste of money could easily be stopped if we were willing to do a little more research on body measurements, and revise our practices in sizing and fitting.

The fourth question we want to have answered is, what does the name or descriptive adjective mean?

Many new and unfamiliar materials are being made today, and more are promised for tomorrow. Some progress has been made by rulings of the Food and Drug Administration and the Federal Trade Commission. Fiber content must be stated on textile labels. Such words as "washable" and "preshrunk" have been given a definite meaning.

Much remains to be done, however. Sterling silver, for example, is identifiable by mark, but the thickness of silver on plated ware varies so much that articles called "silver-plated" may be either a good or a very poor investment. Practically anything may be called broadcloth. The British were many years ahead of us in this field when they published a dictionary of standard retail terminology, called *The Intelligent Woman's Guide to Shopping*. Now a new committee under the American Standards Association is beginning to tackle the definitions of terms used in retailing which have long been needed in this country.

We come now to the question which generates so much emotion in the supposedly cold, scientific realm of standards—what is the article's relative worth?

Many factors are involved in the standards which help us compare similar articles designed for the same need, in order to decide which is the best choice for our individual circumstances. Standards defining relative worth are the basis of every effort to grade products and rate them according to their over-all quality, to state as accurately as possible their performance in use, durability, cost of operation and upkeep, suitability for different uses.

There used to be a notion that the demand for standards defining relative worth was a deliberate attempt by a few consumers to undermine the prestige of brand names. This misconception still lingers among the less flexible minds which find it hard to change old habits.

We all want brand names to mean something definable. Textile concerns experimenting with specification labels which revealed quality differences found them an asset to their brand names. A mail order company reports large savings to itself since it began to define in the catalogues the differences between good, better, and best merchandise.

When a woman buys a long-coveted washing machine for home laundry, she is looking primarily for a piece of equipment that will get clothes and household linens clean. She also wants it to be durable, because it is an investment she cannot repeat often. She wants it to be well engineered and tested before it is placed on the market. She wants it to wear evenly, not rust in spots or require replacement of one part after another. She wants safety devices on wringers and smooth edges that will not catch or tear fabrics. And above all, she wants to compare these and other factors in the different machines on

the market, so she can decide which may be the most satisfactory for her needs at the price she can afford to pay.

Obviously, the question of relative worth is complicated, and not many homemakers have given the detailed consideration to what they want that would help standardizers or manufacturers. The American Home Economics Association has found a way, however, to enable homemakers to discuss and reach agreement on their needs and preferences—a discussion group program called "The Consumer Speaks."

The report indicates that with respect to house dresses, 11,577 members of groups affiliated with the largest and most prominent women's organizations in 22 states of the country voted on what they wanted. They pointed the way to standards of relative worth by defining the characteristics they expected in low, medium, and high-priced ranges.

I commend this report to you for the insight it affords into what consumers want in standardization, even for a product where fashion is a consideration. For example, color fastness ranked above all other characteristics in the number of votes. Next was shrinkage control, and then weaves that are durable and will not stretch or ravel. Women are interested in the quality of thread, in the kind of buttons and the way they are attached, in belts, buckles, and workmanship. If women could find a brand name in house dresses which stood for these definable factors, which frankly stated these quality factors in relation to prices for the good, the better, and the best, that brand name soon would be worth a lot to its owners.

A sixth question is in buyers' minds now because of our experiences during recent years—is this article worth anything at all?

Minimum standards that would place a floor under quality never seemed so important before. The general feeling has been that they were unnecessary if standards defining relative worth could be developed. But the profligate destruction of our resources in war has put the individual's financial losses from worthless goods in a new perspective. We all know now that even this fabulously rich country cannot afford to waste materials and manpower on products that are worse than useless.

Examples of such worthless goods are familiar to us all. Why make a woman's blouse that the retailer tells customers is not guaranteed either to wash or dry clean? Why make slips of nylon that can be worn only once because all the seams pull out? Why put children's shoes on the market with soles that come loose and thread that breaks in the seams with the first week's wearing? Why the many worthless cooking utensils on the market, pots too thin or with handles that are actual hazards? If minimum standards are necessary to prevent such goods from being offered for sale, we should develop them for the sake of our country's resources, as well as our own.

Even so brief a survey as this reveals the tremendous job to be done on standards for consumer goods, if we all are to realize the buying power of our incomes. Estimates indicate that we could buy 25 per cent more with our money, if individual consumers had the facilities for rational choices which are now available to business purchasing agents.

But the best standards for consumer goods will not accomplish this desired end unless they are stated in terms understandable to a literate person, and carried through from producer to retailer to consumer in advertising, and in informative labels attached to the products wherever possible.

The American Standards for coal are an example. Since their development, they have been used in the wholesale trade and by large quantity buyers. They are a good illustration of standards that take into account performance and suitability for different uses. But the standards are printed in technical terms; few buyers for the 40 million homes of the nation can interpret or apply them. A similar example is the American Standard for gas ranges, which also includes performance tests. But information useful to consumers now seems to get lost somewhere between the engineering department, testing laboratory, retailer, and ultimate consumer.

The British have anticipated the need of consumer standards that are understandable to the nontechnical person. Their standards for building materials and structure are expressed in clear, simple words with a minimum of technical jargon and with no sacrifice of technical competence. The aim is to make them useful to home-hungry citizens. The American Society for Testing Materials has just published a suggested specification form for ultimate consumer goods which also is an excellent model for our use. The usefulness of standards could be greatly extended if they were written in language more meaningful to the buyer at retail.

It is the confident belief of many who have given thought to standardization of consumer goods that eventually we will find simpler and better methods of defining and stating information we need about our goods and services. Specification standards and labels are indispensable now, and represent the best we are capable of formulating at the present stage. But we are just beginning. We can expect our consumer goods standards of the future to bear about the same relation to those of today as the Wright brothers' first plane does to the present-day Constellation.

Our economic system now is on trial before the world. It cannot prove the strength that we believe is inherent in it, if its vast consumer market is served on the basis of exploiting ignorance and confusion. As consumers, we cannot exercise our function of automatic control unless we have the facts that make our choices meaningful. We need to know what we are buying, not only for our individual protection and satisfaction, but for the sake of preserving the freedom of private enterprise. Regulatory laws and government controls arise among a freedom-loving people only when we fail to cooperate in trying to solve problems of general concern. Through the standardization of consumer goods, we can enable each other to make a contribution, vital and as yet scarcely implemented, toward keeping our free enterprise economy healthy, vigorous, and sound.

Textile Testing in Germany*

By Herbert F. Schiefer,[1] Lyman Fourt,[2] and Richard T. Kropf[3]

DURING the years of World War II, and for quite some time prior to the actual hostilities, there had been a black-out or actual distortion of news concerning the details of the feverish scientific activity within Germany.

In order that this work could be brought to light and made available to everyone in the United States, a number of American Scientists specializing in various fields, were called upon to investigate the work in Germany in their respective fields of specialization.

In conjunction with the study of textiles, the subject of textile testing was thoroughly investigated. This work was done by a team of textile scientists serving as scientific consultants to the Technical Industrial Intelligence Committee and to the Office of the Quartermaster General. As members of this team, the authors have highlighted in the following sections the key items in this very broad subject. A comprehensive report of their findings is being prepared and will be published in the near future.

Fiber Testing

Schopper Tester:

The testing of individual fibers for breaking strength and extension was a routine procedure in Germany. The Schopper single fiber strength tester, shown in Fig. 1, was used most extensively. It is of the pendulum type and was skillfully developed for routine testing.

The pendulum is mounted on a knife-edge and when no auxiliary weight is placed on it to obtain a given load capacity, it is in equilibrium for any angular position. It is claimed that the inertia has been kept so low that the precision of the indicated load is 0.5 per cent of the full scale value and 1 per cent at any intermediate load. The two scales for indicating the load and the extension are linear. One division of the load scale is equal to $\frac{1}{100}$ of the auxiliary weight which is attached to the pendulum for a test. Seven such weights are provided to give load ranges from 0 to 1, 2, 5, 10, 20, 50, and 100 g., respectively. Extensions up to 25 mm., magnified four times, can be measured. The value of one division of the scale is 0.2 mm. and estimates to 0.1 mm. extension can be readily made. An electrical trip mechanism is provided to disengage the extension indicator at the instant the specimen breaks.

Specimen lengths ranging from 10 to 100 mm. can be tested dry, and lengths ranging from 10 to 50 mm. can be tested wet. Provision is made for immersing the lower clamp and specimen in the liquid during the entire test. The load-extension curve can also be recorded throughout the test on a chart. Repeated loading and unloading curves can be recorded.

Extensions up to 5 mm. can be measured more precisely optically, with an uncertainty of only 0.05 mm. For this purpose a small microscope is attached to the lower clamp. A scale in the field of the microscope is adjusted so that the zero coincides with a reference mark of the upper clamp. The relative displacement of the two clamps, the extension of the specimen, can be read directly by looking through the microscope and noting the position of the reference mark on the scale. The instant when the specimen breaks can be observed from the

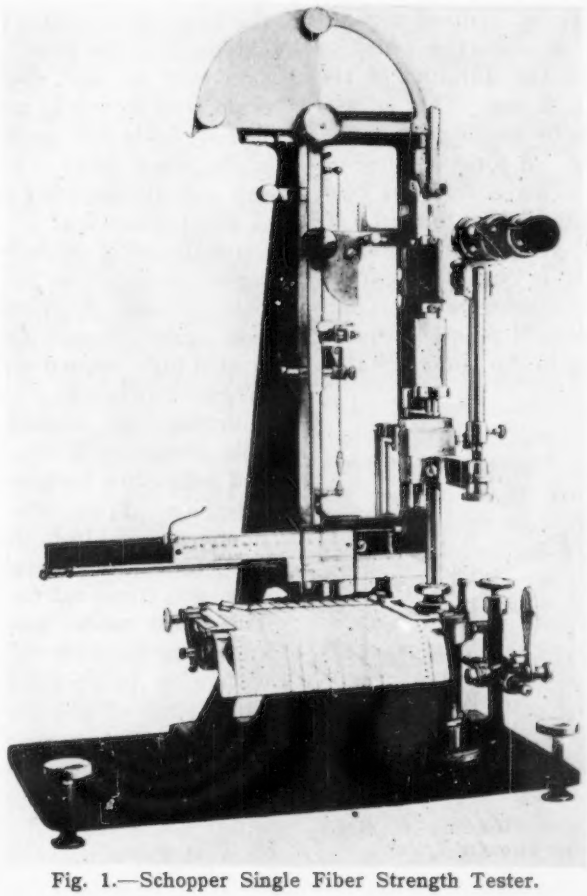


Fig. 1.—Schopper Single Fiber Strength Tester.

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* Presented at the October, 1946 Meeting of Committee D-13 on Textile Materials.

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[3] Director of Research, Belding Heminway Corticelli, New York, N. Y.

sudden movement of the reference mark caused by a slight swing-back of the pendulum. This method of obtaining the extension requires very careful attention, a technique which can, however, be readily mastered by a qualified operator.

About 50 to 60 fibers can be tested in an hour by an experienced operator. The fibers are inserted in the tester under an initial tension which is about equal to the weight of 500 m. of the fiber. Small clamps of the required weight are suspended from one end of the fiber while the other end is fastened in the upper clamp. The speed of the lower clamp, which is usually driven hydraulically, is adjusted by means of a sensitive valve so that the duration of the test is 20 ± 2 sec. This adjustment is made by making a few preliminary tests. A constant time interval for making a test has been adopted as standard for tension testing of fibers, yarns, and fabrics in Germany. It is one of the specification requirements which differs from the standard practice used in textile testing in the United States.

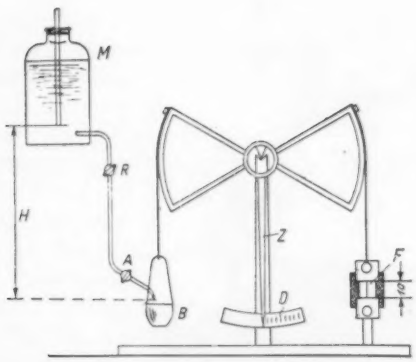


Fig. 2.—Schematic Drawing of Krais Single Fiber Strength Tester.

Krais Tester:

The Krais single fiber tester, which was also used extensively in Germany, is of the constant rate of loading type and is generally known as "Deforden." It was constructed by H. Keyl at Dresden and is basically a balance as shown schematically in Fig. 2. The load is applied to one end of the balance by water flowing from a bottle M into a vessel B at a constant rate. The rate is adjustable by the water head H and the valves R and A. The other end

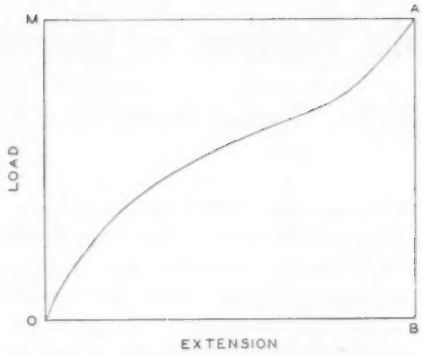


Fig. 3.—Load-Extension Diagram.

of the balance beam exerts the load on the fiber F. The deflection of the beam Z is proportional to the extension of the fiber. This extension may be read directly from a scale D or it may be greatly magnified optically and read on a scale in a darkened room. The extension can also be recorded against time. A chart, placed at D, is oscillated vertically at a uniform rate and a scriber fastened to the end of the balance beam Z records the extension against time. The zigzag record of high frequency indicates low extension, whereas a low frequency indicates high extension. A variable frequency is readily detected and indicates a variable time rate of extension. From the time-extension record and from the known uniform time rate of loading, a load-extension curve can be constructed. The latest model made by Keyl, known as "Deforsom," is provided with a valve operated electrically which shuts off the flow of water at the instant the specimen breaks and includes an optical extension indication of 100 magnification and an automatic device for recording the load-extension curve of the fiber. Provision is also made for immersing the fiber in water during a test to obtain the wet strength and extension.

Interpretation of the Load-Extension Diagram:

The load-extension curve was a subject which received much thought and study by some of the German textile scientists. It was but natural that many involved and complex interpretive techniques should have been worked out. Many of these were useful only as research tools; however, the interpretation which follows was employed for a standardized test.

Figure 3, curve OA is observed as the load-extension (to rupture) diagram for a textile fiber. Here the area OAB is measured and is equal to the work W expended to break the fiber. This is called "deformation work." The maximum work W_M which could be done on a theoretically ideal fiber having the same breaking strength and extension at rupture would be equal to the $OMAB$. From the foregoing values, a "degree of achievement," V, is calculated, where

$$V = \frac{W}{W_M}$$

From this point, the interpretation employs data obtained from a series of loading and unloading curves applied to a single fiber in accordance with a plan approximating that given in the following table:

Loading Step	Applied Load as a per cent of Breaking Strength
Initial	10
2	20
3	30
4	40
5	50
6	60
7	70
8	80
9	90
Final	Rupture

By referring to Fig. 4, a load-extension curve OA_1 is observed resulting from an initial load OM_1 with a resulting extension OB_1. Upon unloading, OC_1 is observed as a non-recoverable extension, while C_1B_1

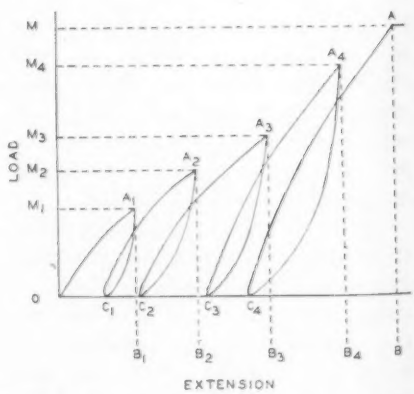


Fig. 4.—Repeated Progressive Loading and Unloading Extension Diagram.

represents the elastic or recoverable extension. The second step of loading OM_2 is then applied resulting in the curve C_1A_2. Upon unloading,

the nonrecoverable extension is now observed as OC_2, while the elastic or recoverable extension is C_2B_2. These successive steps are continued until the yarn fails at load OM at extension OB.

With the data resulting from the above procedure, an interpretive diagram is now constructed as shown in Fig. 5. In this diagram, the points A_1, A_2, A_3, A_4 . . . A, are plotted from the points of extension OB_1, OB_2, OB_3, OB_4 . . . OB, for the progressive loads OM_1, OM_2, OM_3, OM_4 . . . OM. The area under this curve OAB is equal to W_A or the work done.

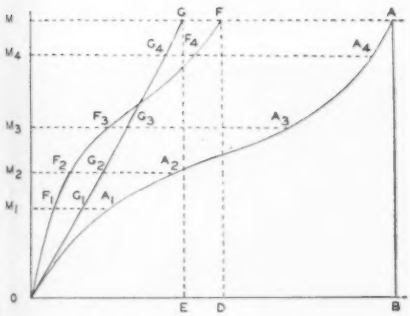


Fig. 5.—Interpretive Diagram.

The recoverable extension, C_1B_1, C_2B_2, C_3B_3, C_4B_4 . . . for the progressive loads OM_1, OM_2, OM_3, OM_4 . . . are plotted as M_1G_1, M_2G_2, M_3G_3, M_4G_4 . . . with a curve drawn through G_1, G_2, G_3, G_4 . . . and extended until it intersects the line of the breaking load at G.

Likewise, the nonrecoverable extension OC_1, OC_2, OC_3, OC_4 . . . for the progressive loads OM_1, OM_2, OM_3, OM_4 . . . are plotted as M_1F_1, M_2F_2, M_3F_3, M_4F_4 . . . with a curve drawn through F_1, F_2, F_3, F_4 . . and extended until it intersects the line of the breaking load at F.

The area under the curve OGE is equal to W_G or the work recovered. The area under the curve OFD is equal to W_F or the work lost. Thus the work lost, W_F, plus the work recovered, W_G, equals W_A or the work done.

From the foregoing, the elastic efficiency of the fiber in question is defined as:

$$\text{Elastic efficiency} = \frac{W_G}{W_A}$$

If those qualities are expressed in terms as of the unit weight of the fiber, they are referred to as specific total work, the specific permanent work, and specific elastic work.

Yarn Testing

Schopper Tester:

The Schopper yarn tester was of the pendulum type equipped with an automatic recorder of the load and extension. As in the case of the single fiber tester, the yarn tester was provided with a scale indicating the extension of the specimen. The older models were equipped with a gravity trip mechanism which disengaged the extension indicator when the specimen broke. This was not always satisfactory. The newest model was equipped with an electrical trip mechanism operated by the pawls of the pendulum. The pawls were attached to the end of a lever which was pivoted at the other end on the pendulum. When the specimen broke, the pendulum could swing back a small amount until the lever made contact with a stop on the pendulum. This slight motion of the lever relative to the pendulum closed an electric circuit and caused a solenoid to disengage the extension indicator.

The breaking strength of yarns depends greatly upon the amount of twist, and to facilitate studying the effect of twist the Schopper Co. developed a special lower clamp for the yarn tester. With this clamp the twist in a yarn could be increased or decreased and in fact even reversed in direction after the yarn specimen was inserted in the tester. This permitted studying the effect of twist on the breaking strength and extension of yarn, even if only a small quantity of yarn was available.

Continuous Yarn Testing:

The German textile technologist has shown a great deal of interest in the continuous testing of yarns. Considerable work was done in this field and several better known instruments were developed to achieve these ends.

Frenzel-Hahn Universal Yarn Tester.—This instrument applies a constant extension to the yarn as it is passed through at a constant rate of speed, while the resulting variation in the yarn tension is recorded. By referring to Fig. 6 it will be noted that the yarn is threaded first over a length-measuring device and then through the first feed roll assembly. From the first feed roll the yarn is passed over a tension measuring and recording roller and then through the second feed roll assembly. From this point the yarn passes over a second length-measuring device and thence to the final take-up reel.

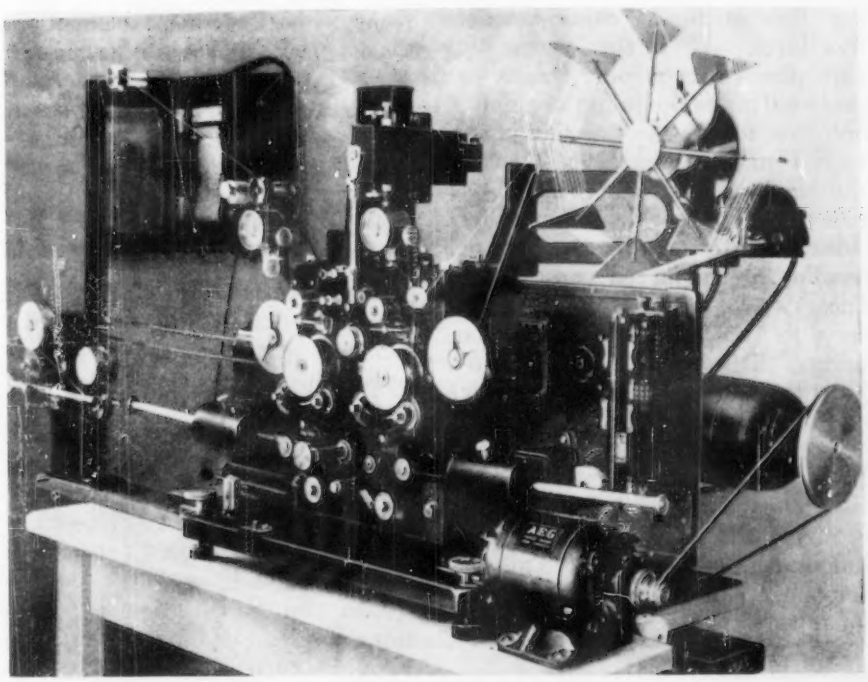


Fig. 6.—Frenzel-Hahn Universal Yarn Tester with Magnetic Strain Gage.

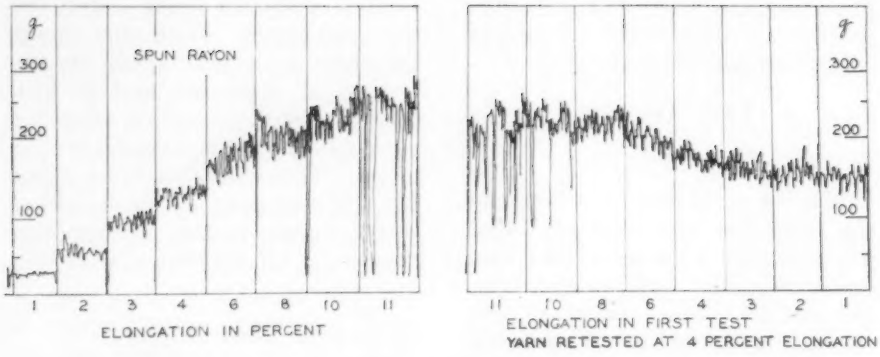


Fig. 7.—Typical Test Record Obtained with Frenzel-Hahn Tester.

The instrument was so designed that the speed of yarn passage could be adjusted to any value between 5 and 60 m. per minute. Likewise, through changing the feed roll drives, any extension between 0 and 40 per cent could be achieved. In the earlier instruments, the tension was measured by means of the conventional angular deflection of a pendulum. This system introduced numerous errors, however, due to the inertia of the assembly, and actually caused variations in elongation due to the movement of the tension measuring roller linked to the pendulum. Likewise a gage length that became undesirably long was another problem occasioned by this type of tension measuring system.

To overcome these difficulties, a tension measuring system employing the Magnetic Strain-Gauge[4] was developed. In this system the yarn passes over a roller similar to that used in the pendulum assembly; however, in this case the link is attached to a calibrated cantilever, the small deflection of which is a function of the tension. On either side of the cantilever, in the plane of bending, are mounted two inductances which in turn are made to serve as two legs of an inductance bridge. This bridge circuit, in conjunction with auxiliary electronic amplifiers, is connected with an indicating and recording galvanometer. In operation, the tension applied to the roller deflects the cantilever, changing the air gaps between the inductances on each side. This results in an unbalancing of the inductance bridge, which unbalance is amplified and recorded by the galvanometer. The cantilever and circuit are carefully adjusted and calibrated so that the resulting autographic record is direct reading.

The general practice followed with this instrument was to test successive lengths of yarn with a definite increase in deformation of 2 per cent until excessive breakage occurred. During each of these runs, the tension was recorded, together with the number of breaks and permanent elongation as calculated from the length-measuring device before and after the feed rolls. Frequently the yarn is passed through the machine a second time to study fatigue and various other effects. An examination of the left-hand chart of Fig. 7 will show an example of a series of runs on a spun rayon yarn, in 1 per cent steps, from 1 to 9 per cent elongation. This same yarn was then re-run through the machine at a fixed elongation of 4 per cent. The result of this re-run is shown in the right-hand chart of Fig. 7. As can be well understood, many variations and special applications were worked out and used.

Dietz Continuous Yarn Tester.—This particular instrument applied a constant tension to the yarn as it passed through at a constant rate of speed, recording the variation in elongation at this constant tension. A length of 50 or 100 m. was passed through the instrument for a test. The yarn from the take-up reel was weighed to determine the yarn number, the number of breaks observed, and the variation in elongation recorded. From these data the "ten-break tension," or tension which would cause the yarn to break 10 times in 1000 m. is calculated. It is interesting to note that the value of this "ten-break tension" varies from about 35 per cent of the average breaking strength for linen to about 85 per cent of the average breaking strength for silk.

It should be noted that there is a special Frenzel-Hahn instrument designed to test yarns in a manner similar to the above-mentioned Dietz instrument.

Fabric Testing

Breaking Strength:

The breaking strength of fabrics was usually determined on a pendulum type tester manufactured by

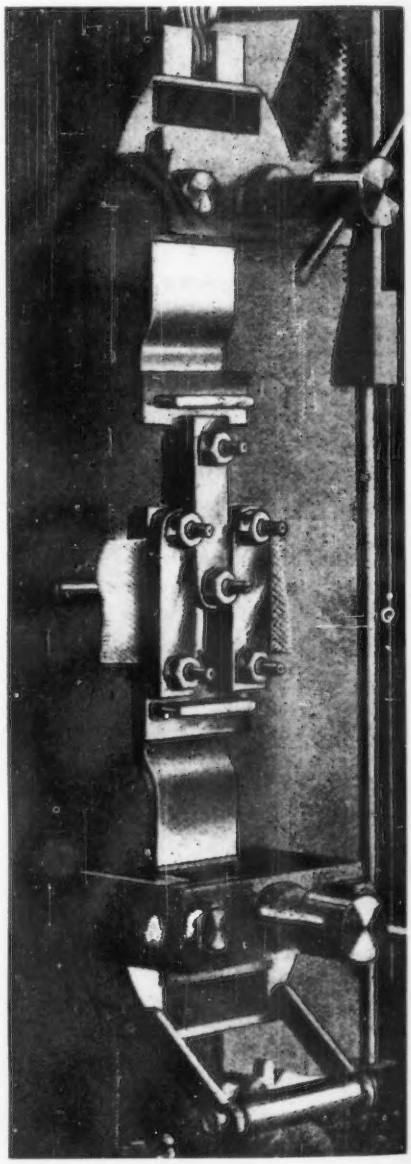


Fig. 8.—Special Clamp for Testing Shearing Strength of Fabrics.

[4] This is but one of a number of applications of the Magnetic Strain-Gauge observed in Germany. This equipment was developed and distributed by one of Germany's large electrical manufacturers.

Schopper which embodied the same features as for yarns. The machine was available in three models, each having three capacities. The capacities were the following:

Light machine..... ..... 50, 100, and 250 kg.
Medium machine..... .....100, 250, and 500 kg.
Heavy machine..... .....200, 500, and 1000 kg.

Shearing Strength:

A clamp, known as "Buskop," shown in Fig. 8 was manufactured by Schopper for measuring the shearing strength of fabrics. The shearing force was applied in the plane of the specimen at right angles to the length of the specimen.

Tearing Strength:

The tearing strength was measured in the usual manner. To eliminate the large inertia forces arising from the oscillations of the pendulum in tear testing, experiments were made in which a pressure-sensitive carbon resistor and oscilloscope were used as a force-measuring unit. The oscilloscope pattern was photographed with a high-speed camera from which the variation in load as a function of time was obtained as the tear progressed across the specimen thread by thread.

Bursting Strength:

The methods and equipment for measuring the bursting strength are of two types as in the United States. In one a clamp is provided for the Schopper fabric tester in which a ball is forced through the fabric similar to the ball burst test in the United States. In the other a yielding membrane, over which the specimen is clamped, is deformed by the application of a pressure until the deformation is sufficient to rupture the specimen. This procedure is similar to the Mullen burst test in the United States.

Sommer worked out functional relationships between breaking strength and bursting strength which have been used very generally in German textile laboratories. Since these relationships involved complicated algebraic and trigonometric terms, Sommer and Schwerdt developed special slide rules to simplify the calculations.

Abrasion Testing

Jansen Tester:

The Germans developed a number of abrasion testers for yarns which in many cases could also be used for fibers. The Jansen tester shown schematically in Fig. 9 is typical of several testers which were used for yarns. A yarn, designated by *1* in the figure, is fastened to two clamps of a horizontally reciprocating member. A second yarn, designated by *2*, is fastened at one end to a fixed clamp and is then passed underneath the middle of the first yarn and over two pulleys with a weight attached to the free end. The two yarns are flexed and abraded against each other until one of them breaks. The number of reciprocations to failure is recorded.

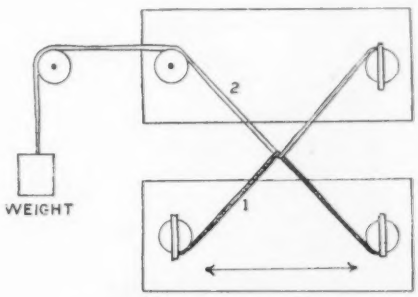


Fig. 9.—Schematic Drawing of Jansen Yarn Abrasion Tester.

Schopper Tester:

The Schopper abrasion tester, shown in Fig. 10, is used most widely for testing fabrics in Germany and is the machine specified in the German Standards (DIN) for fabrics. The specimen is clamped over a circular convex surface which rotates and reverses in direction of rotation after a specific number of rotations. A weight with an abrasive paper on the under side is brought in contact with the fabric. The axis of the rotating member makes an acute angle with the surface of the abrasive paper. The decrease in bursting strength after a specific number of rotations and the number of rotations to produce a hole are used to evaluate the resistance to abrasion.

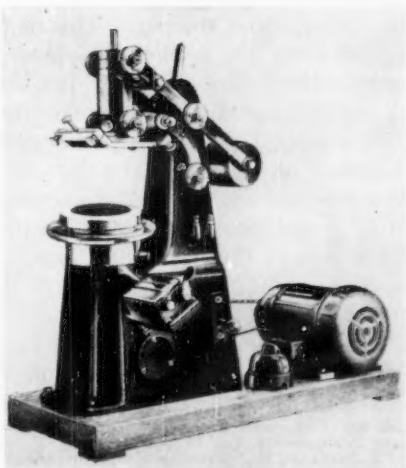


Fig. 10.—Schopper Abrasion Tester.

Mueller Tester:

The Mueller fabric abrasion tester is typical of the kind in which a strip of fabric is clamped under a given tension over a horizontal plate and a reciprocating weight with an abrasive paper on the under side is brought in contact with the fabric specimen. The weight is reciprocated back and forth and abrades the fabric in the direction of the applied tension. The change in breaking strength with the number of reciprocations is measured to evaluate the resistance to abrasion.

Weltzien Tester:

The Weltzien abrasion tester is a modification of the Mueller type in which the specimen is similarly mounted under tension but is not in contact with a horizontal plate. The abradant is fastened to the end of a vertical arm which is rocked back and forth through an angle of 90 deg. The arm deflects the specimen downward at the middle of each stroke and abrades the fabric. By placing a shallow dish containing water underneath the specimen, that portion which is abraded is immersed in water and the specimen can be tested in a wet state.

Stoll Tester:

The Stoll tester, shown schematically in Fig. 11, is typical of the kind in which the fabric is flexed and abraded against itself. The specimen is clamped to the left edge of the bottom plate, which is reciprocated horizontally. The specimen is folded over to the middle of the bottom plate and then back on itself and fastened to the left edge of the upper plate. The folded specimen

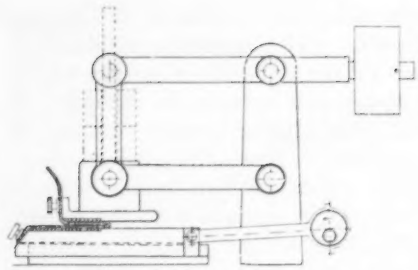


Fig. 11.—Schematic Drawing of Stoll Abrasion Tester.

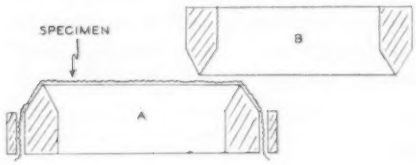
is compressed between the two plates under a known force acting through the upper plate. The change in breaking strength with the number of horizontal reciprocations of the bottom plate is used to evaluate the fabrics for resistance to flexing and abrasion.

I. G. Farben Circular Edge Tester:

The I. G. Farben tester, shown schematically in Fig. 12, was developed to measure the resistance of fabrics to abrasion at localized edges such as at cuffs and collars. The specimen is mounted with constant tension over the metal cylinder *A* with specially shaped rims of hardened and polished steel. A separate setup is used to apply the tension in mounting the specimen. A similar metal cylinder *B* rests on the specimen under a definite downward force. The cylinder *B* is placed eccentrically with respect to cylinder *A* so that the central angle subtended by the intersecting chord *CD* is 90 deg., which is the position that produces maximum wear. The diameter of the two cylinders is 17 mm. They rotate in opposite direction with a speed of 300 rpm. The test is usually made with cylinder *B* bare so that the end of the test is indicated by an electrical signal when a hole is worn through the specimen and contact is made between the two cylinders. The tension in mounting the specimen is adjusted to values between 500 and 2000 g., and the downward force of cylinder *B* on *A* is adjusted to values between 50 and 500 g. so that the duration of a test is between 20 and 100 sec.

Flexing-Endurance Testing

Closely related to abrasion resistance is resistance to flexing. The instrument built by Schopper, Fig. 13, is similar in essentials to the M.I.T. fold tester. The specimen is gripped in jaws, rounded to a radius of 0.05 mm., which bend it back and forth 120 times a minute through 180 deg. until it breaks. The load on falling trips an electric stop switch, and the number of bends is read from the counter. When this device was introduced[5] data were presented showing that, for a given material, there is a linear relationship between the logarithm of the number of folds and the tension. Schopper suggests that this can be



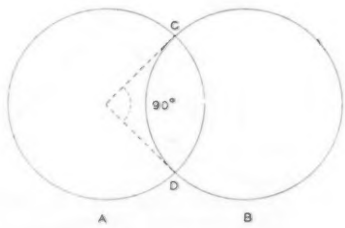


Fig. 12.—Schematic Drawing of I. G. Farben Circular Edge Abrasion Tester.

extrapolated backwards to give theoretical flexing endurance at zero load. The standard procedure for comparative testing, however, is to use 10 per cent of the breaking load.

Similar devices have been developed by Franz and Henning[6] for single fiber testing, using a bar carrying ten or so small clamps, the fibers being bent at the point of clamping by movement of the bar. The load on the fibers was applied by a lever, which carried a writing pencil. When an individual fiber broke, its lever dropped, and the pencil began to record on a drum. The distance from the starting point to the beginning of the record gave the flexing endurance of the particular fiber.

Spinning Tests

With the intense interest in Germany in the development of new

[5] A. Schopper, "Dauerprüfung von Textilien" (Flexing Endurance Testing of Textiles), *Melliand Textilberichte*, Vol. 17, p. 844 (1936).

[6] E. Franz and H. J. Henning, Knickbruchfestigkeitsprüfung von Einzelfasern" (Bending and Breaking Tests of Single Fibers), *Ibid.*, Vol. 17, p. 121 1936).

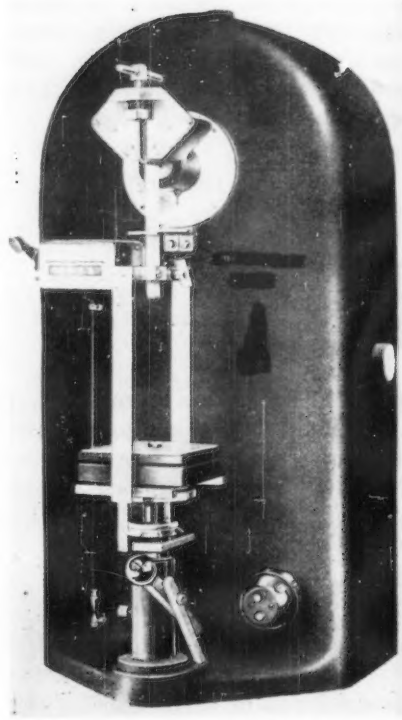


Fig. 13.—Schopper Flexing Tester for Fabrics.

fibers, mostly variations on viscose rayon, there was a need for small-scale testing of spinning characteristics. This was met by a device, about the size of a small desk, called the "Spinn taxer," made by Rudolph Knote in Leipzig, as shown in Fig. 14. The device has two parts, a small card, requiring only 45 g. (0.1 lb.) of staple, and a single ring spinning spindle. In use,[7] the staple is given a preliminary carding and removed as a fleece, and a second carding, from which it is removed as a top. This is then drafted and spun to a yarn in the range from 6 to 10 English number

[7] E. Wagner, *Ibid.*, Vol. 23, pp. 118–120 (1942).

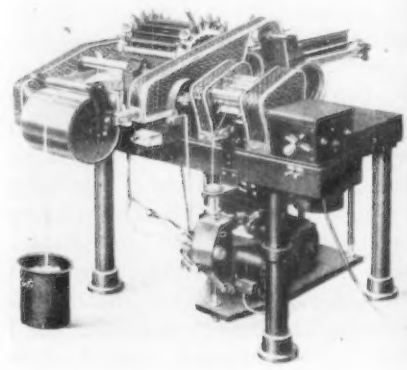


Fig. 14.—Spinn Taxer.

(cotton count). The breaking strength of the yarn so produced is compared with the breaking strength of similar yarn produced from comparison materials. The "Spinn taxer" can be used to study the effect of twist, or of lubricants applied to the staple. The yarns produced were somewhat lower in utilization of the inherent strength of the individual fibers than standard large scale spinning, since standard production usually gives from 50 to 55 per cent of the fiber strength, but the "Spinn taxer" gives only about 45 per cent. Nevertheless, the value of such a device for development and testing work is obvious.

Measurements on Staple

A constant care of each of the rayon plants was the maintenance of uniformity of staple. A large fraction of the personnel and space of the rayon laboratories was taken up with this control work. As nearly as could be observed, however, the interpretation of production control appeared to be intuitive, rather than being systematized in the control-chart methods which the A.S.T.M. has helped to introduce in this country.

Every rayon laboratory was equipped with knives and torsion balances for determination of denier. The staple was combed and stretched across a steel anvil, for example, 2 cm. wide. Two knives operated by a lever cut out the staple at the two sides of the block. The operator would then count out bundles of 50 fibers for weighing to determine denier. The same method was often applied to continuous filament.

One of the few electronic instruments seen in German textile laboratories was an importation from Holland, namely, Gonsalves'[8] device for determination of denier on an individual filament. This used the basic law of the violin string, that the frequency (pitch) is dependent on the length, the mass of the fiber, and the tension on it. Single fibers were attached to the element of the loudspeaker unit, which could be tuned until resonance was seen in the fiber. The tuning control was calibrated to read the frequency. From this the weight per unit length, that is, the denier, could be found. The device was calibrated by cutting segments from continuous filament rayon, and an accuracy of 3 to 4 per cent was claimed.

Alternatively, the methods developed for wool could be used. These were two: one, the projection of a large number of cross-sections on the screen (the standard section cutter appears to be identical with that of Hardy of the U. S. Department of Agriculture); the other method, the Rapid Lanometer, measures the area of a bundle of fibers in a square wedge, under a standard pressure, as shown in Fig. 15.

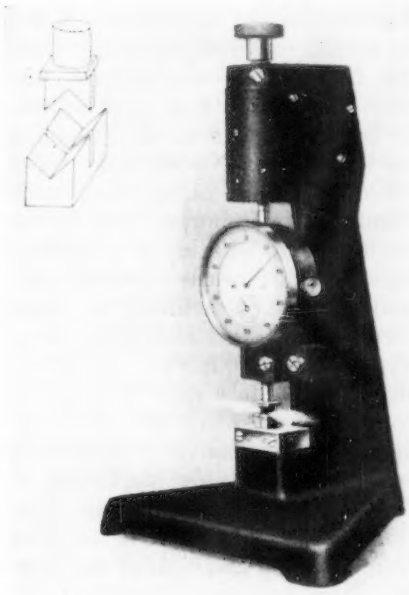


Fig. 15.—Rapid Lanometer.

Staple length was usually determined in the combing device shown in Fig. 16, which was developed by Johannsen, made by Zweigle. The chief difference between this and the Suter-Webb Duplex Sorter used for cotton, or the Suter Wool Sorter, is in the hinging of the two banks of combs so that the upper bank can be pressed down into the lower, reducing the sorting interval to one half.

Shrinkage and Creping Measurements

There appeared to be an emphasis on shrinkage measurements in Germany at the yarn stage, as well as on the fabric as is currently so large a question in this country. A convenient device for multiple observation of yarn shrinkage was seen in several laboratories, consisting of a rack from which ten yarns could be hung, in front of a sheet of cross-section paper. Such a rack would be about 2 m. high, with the yarns hung for initial dry observation in the upper half. The lower half was filled by a frame carrying a corresponding number of glass tubes which could be raised to immerse the respective yarns. After a suitable period, the glass tubes could be racked down again and the yarn length observed after drying.

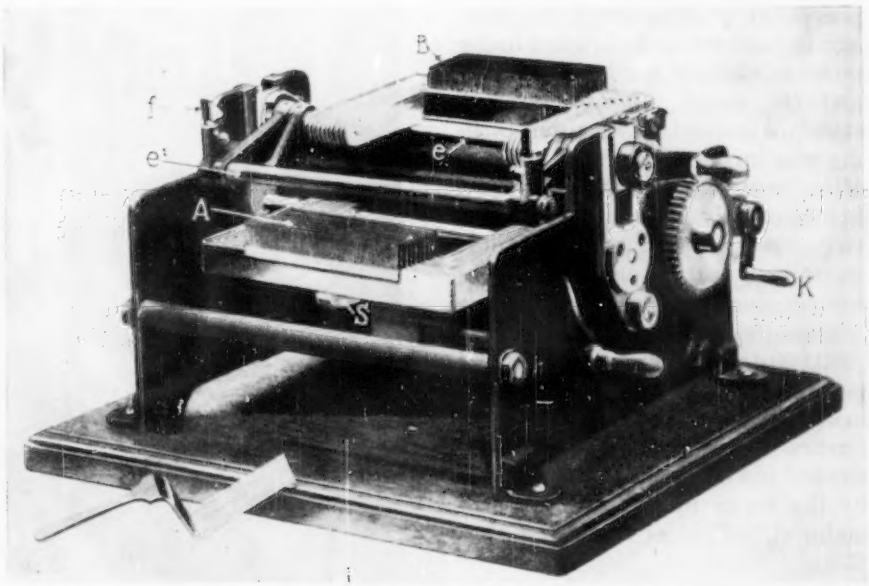


Fig. 16.—Johannsen-Zweigle Staple Length Tester.

[8] V. E. Gonsalves, "Eine moderne Apparator für die Bestimmung der Festigkeit und Dehnung der Einzelfasern" (A Modern Apparatus for Measurement of Strength and Extensibility of Single Fibers), *Ibid.*, Vol. 24, p. 218 (1943).

Another device was well adapted to observation of creping tendency by determination of the force of contraction. In this, a battery of levers and indicating pointers is arranged to load yarns with a series of weights, increasing from one lever to the next. The creping bath is then raised to immerse the yarns. Some of the weights stretch the yarn; some are less than the creping tension, and from the plot of change of length against load the point at which there is no change of length indicates the creping tension.

A third device, to study shrinkage from the point of view of yarn uniformity, was seen in Weltzien's laboratory at Krefeld. A similar device was recently described by Eyre[9] in England. The yarn is wound under constant tension onto a cylinder where it is marked by a resistant ink in a straight line drawn the length of the cylinder. The yarn is then wound off in a skein, treated with water, alkali, or otherwise, dried, and wound onto the cylinder again. The markings now produce a spiral, because of shrinkage, and variability along the yarn is revealed by variations in the pitch of the spiral.

Swelling

In the rayon-dominated textile picture in Germany, methods to improve the strength and durability of rayon occupied a position only second to methods of production. The leading idea was that if the swelling of rayon in the wet state could be prevented or diminished, the damage in washing and abrasion under moist conditions would be reduced and the useful life extended. A standard method of measuring swelling was in terms of water retained after centrifuging. The essential points of this method were: wetting out for 30 min. in distilled water plus wetting agent at 20 C.; centrifuging in a basket centrifuge at a specified centrifugal acceleration (600,000 to 800,000 cm. per second per second) for 2 min. The decrease in swelling was calculated as the difference in retention between untreated and treated material, divided by the water uptake of untreated material. Typical values resulting from such measurements are the following, taken from a study by Wagner.[10]

Finish	Water Uptake		Swelling Decrease	
	After 1 Wash, per cent	After 50 Washes, per cent	After 1 Wash, per cent	After 50 Washes, per cent
Regular	86	91	..	..
Formaldehyde	60	64	33	28
Resin	61	78	32	12

A technique of estimation of swelling by dyeing was also used which was carried out as follows: Sizing or soluble material is removed from the fabric by appropriate purification. It is then soaked in sodium hydroxide solution of 12° Baumé, 8 to 9 per cent NaOH, cold. The uniform wetting of the piece with alkali is very important and can be improved by addition of a wetting agent. The fabric is rinsed in warm and cold water, acidified in dilute formic acid, rinsed, and dried. It is dyed with 0.2 to 0.5 per cent Sirius light blue B, in a ratio of goods to solution of 1:20 to 1:30 with 0.5 g. Igepon per liter and 5 to 15 per cent salt, at a temperature starting at 40 C. and continuing to boiling. The time varies with the size of the piece from 30 to 60 min. After the dyeing, rinse, and dry.

The dyed piece is compared against standards dyed by the same procedure, which have had their degree of swelling determined by the other method. An eight-step scale from no swelling resistance to good swelling resistance is used.

Testing the Warmth of Fabrics

German workers had a natural interest in the warmth of clothing, but the judgment of Herr Sommer, head of the textile division of the Materialprüfungsamt in Berlin, that the measurements made did not represent a definite physical quantity, is certainly justified. However, there are several points of interest to American workers from the German activity in this field. One such point is the use of wind tunnels to introduce the effect of moving air. The most elaborate of these textile wind tunnels was probably that of Mecheels at Munchen-Gladbach, shown in Fig. 17. The illustration shows the test cylinder, wrapped in cloth, standing on top the tunnel. The test area is 1 sq. m. Although higher wind velocities could be obtained, the usual working speeds were 5, 10, and 20 m. per second, or from 11 to 45 mph. Other workers used lower velocities or made attempts to reduce turbulence around the test cylinder by streamlining it.

In general, the cooling curve was

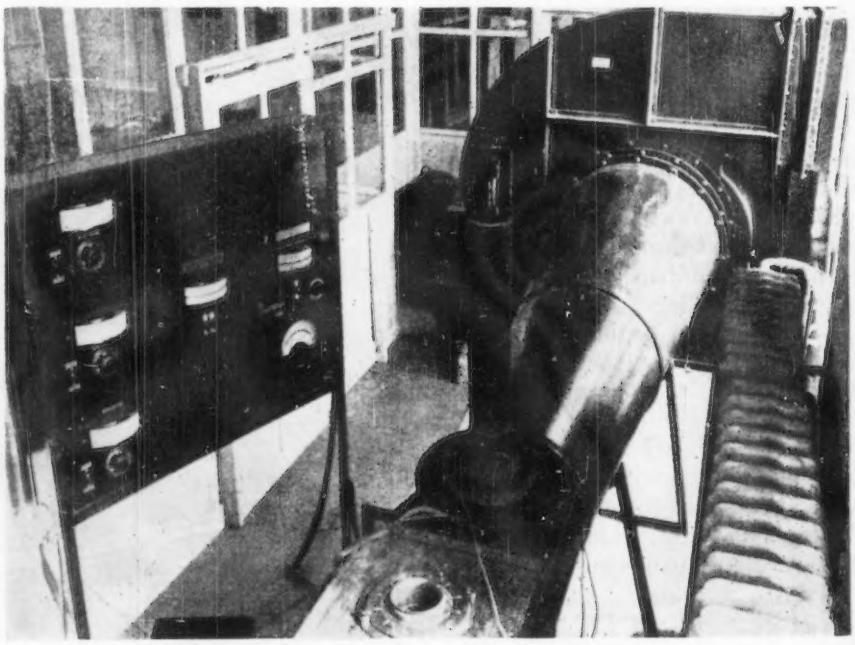


Fig. 17.—Mecheels Thermal Insulation Tester.

[9] N. Eyre, "Testing of Yarns and Fabrics, *Textile Manufacturer*, Vol. 72, p. 179 (1946).

[10] E. Wagner, "Einfluss verschiedener Veredlungsverfahren auf den Gebrauchswert Zellwollener Hemdenstoffe "(Influence of Different Finishes on the Serviceability of Staple Rayon Shirting," *Ibid.*, Vol. 22, pp. 633-635 (1941); vol. 23, pp. 395-399 (1942); Vol. 24, pp. 129-135 (1943), Vol. 25, pp. 378-380, 396-400 (1944); Vol. 27, pp. 84-88 (1946).

used as the basis for comparison. Sommer proposed that the factors of thickness and porosity should be considered by comparing fabrics in terms of the equivalent air layer, which he defined as the product of thickness times the fraction of the volume of the fabric which is occupied by air.

A standard method of measuring thickness is necessary for such comparisons. Sommer proposed for the standard approximation to the original thickness of the fabric that it should be measured at a pressure of 10 g. per sq. cm. (0.142 psi.). The general standard pressure for such measurements, as specified in DIN 3801, was 50 g. per sq. cm. applied over an area of 10 sq. cm. (1.55 sq. in.). Compressibility was expressed as the decrease in thickness between 10 and 100 g. per sq. cm. since it was found for many fabrics that the thickness was proportional to the logarithm of the pressure in the range of pressures from 5 to 300 g. per sq. cm. The usual devices for measurement of thickness were dial indicators with dead-weight application of load.

Testing the Effect of Cloth Surface on the Sensation of Warmth:

A device for comparing the effect of different surface characteristics on the sensation of warmth was seen at the textile laboratory of Vereinigte Glanzstoff, Obernberg. This device had been developed by the filament rayon department, in connection with abraded rayon yarns, in attempts to make the filament rayon take on more of the character of spun staple. It consisted of a grid of wires which were simultaneously the source of heat and the means of measuring it as a resistance thermometer. Current sufficient to maintain the grid at body temperature was let pass through the grid while it was exposed to air. When a piece of fabric was laid on it, the grid was cooled, the more so the smoother the surface of the fabric and the better the thermal contact. This cooling increased the resistance, and the effect on the current was followed on a recording ammeter. The largest changes of temperature were observed with filament rayon, and smaller changes the more hairy the surface.

German Standards Organizations

Typical of the situation in other countries, many independent standardizing agencies had sprung up during the course of the years in Germany and while they were all seriously endeavoring to contribute to the cause of standardization, the situation was quite chaotic.

In 1917 the first attempt to unify all of the agencies began, and finally in November, 1926, the resulting Deutscher Normenausschuss e. V. took form. This organization, identified as DNA, consisting of a joint committee made up of representatives from the government, from the manufacturers, and from the consumers of manufactured products, was the final authority on all German Standards.

Associated with DNA were many suborganizations who concerned themselves with specific industries and fields. This subgroup participation was very broad, even including the Army, Navy, and Air Corps.

The functions of DNA can be broken down into five primary categories:

1. Definitions—Official approval and definition of technical concepts, terms, abbreviations, and symbols.
2. Dimensions and Tolerances—Dimensional standard and tolerances of commercial products.
3. Performance Standards—Quality performance standards for products, machines, and for packing and delivery of goods.
4. Testing Standards—Standard test methods.
5. Safe Practice Standards—Machine and equipment operating and maintenance codes.

The evolution of a standard follows the approximate course (oversimplified for the sake of illustration) given below.

Any person or organization may propose or request a standard. This proposal or request will be referred to one of the specific technical subcommittees of DNA. If there is no subcommittee in the field in question, it will be referred to the subcommittee in a related field or a new specific subcommittee will be formed. After the subcommittee has prepared a tentative standard, it is published in various trade and scientific publications (the *Melliand-Textilberichte* being one of those used in textiles) inviting discussion. After these discussions result in agreement, the final draft is submitted to DNA for approval. When approved by DNA, the standard is assigned a number and issued as a Deutsches Industrienorm or DIN. In attempting to popularize the use of DIN, its actual significance as an abbreviation for Deutsches Industriernorm was placed in the background, and the abbreviation as representing "Das ist Norm" was popularly used.

The German Textile Standards in their final form, although earlier releases followed a somewhat different pattern, were prefixed with the letters DIN and followed by the standard number. DNA had reserved DIN number from 60,000 to 64,999 for textiles.

Prior to the war, the DNA was cooperating with the standard organizations of 26 foreign nations. Some of the DIN's have been available in the United States for various industries. Those covering textiles representing the most recent issues have been collected since the war and are being made available to all those interested through the United States Government.

Acknowledgment:

The authors wish to take this opportunity to acknowledge and express their appreciation for the major contribution made to this work by their teammates and their associates in the Armed Forces, without which this would not have been possible.

Relation of Absorption and Sulfate Test Results on Concrete Sands

By Katharine Mather[1]

THE EXISTENCE of permeable pore space in aggregates is a necessary basis both for the absorption test[2] and the sodium or magnesium sulfate test.[3] It is also an important contributory factor to the failure of concrete exposed to freezing and thawing. Because of the dependence of the absorption and sulfate soundness tests on the amount of permeable pore space in the aggregate, it is reasonable to expect a positive correlation between results of the two tests. As absorption increases, so does loss in the sulfate soundness test. Information on that correlation was recently published by Adams and Pratt.[4] Impetus for the investigation reported here came from consideration of their paper.

The present investigation is based on magnesium sulfate soundness and absorption tests on 409 samples of fine aggregate from the New England, North, and Middle Atlantic states. The samples were submitted to the Central Concrete Laboratory, Mount Vernon, N. Y., for routine tests, including five cycles of the magnesium sulfate test, during the period 1942–1945. No ten-cycle data are included.[5]

Most of the range of mineralogical and lithological composition that might be expected in natural sands in these states is represented. There are sands predominantly quartz; granitic sands (quartz and feldspar); sands in which shale and sandstone are major constituents; sands containing schist and gneiss; and sands made up of quartz, feldspar, and limestone. A few manufactured dolomite and quartzite sands are included.

The major constituents of the natural sands can be roughly classified in order of amount of inherent permeable pore space:

1. *Low:* Unweathered single mineral grains (quartz and feldspar).
2. *Moderate:* Unweathered fragments of fine-grained or well-compacted rocks (quartzite, limestone, schist, and gneiss).
3. *High:* Unweathered sandstone, soft shale.

Natural weathering will tend to loosen and open the structure of any of these. In manufactured sands, incipient fracturing during processing may raise the effective permeable pore space beyond that inherent in the unprocessed rock.

The sands considered are divided into groups according to the Engineer districts by which they were submitted for test. The classification is a geographical one. District names and equivalent areas for the samples included in this study follow:

Baltimore: Central Pennsylvania and Maryland
Boston: Maine and New Hampshire, eastern Massachusetts
Buffalo: Western New York
New York: Eastern and southern New York, Long Island, northern New Jersey
Philadelphia: Eastern Pennsylvania, southern New Jersey and Delaware
Providence: Rhode Island and Connecticut, small representation from western Massachusetts
Syracuse: Central New York and the southern tier of New York.

Test Procedures:

The absorption test was made in accordance with the A.S.T.M. Method C 128[2] except that a separate 500-g. sample was used for the determination of absorption.

The magnesium sulfate soundness test was made and results calculated in accordance with the A.S.T.M. Tentative Method C 88[3] with the following exceptions:

1. The temperature of the sulfate solution was maintained at 80 ± 2 F.
2. The specific gravity of the sulfate solution was always adjusted to 1.295 before the immersion of samples.
3. After immersion for 16 to 18

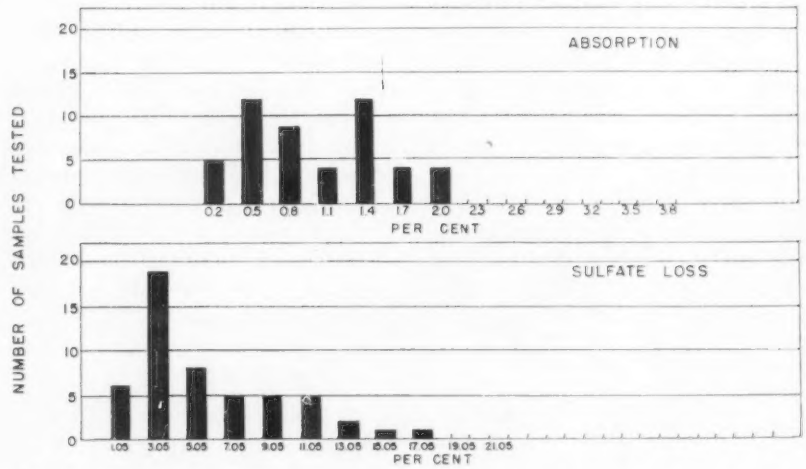


Fig. 1.—Distribution of Fine Aggregate Samples—Baltimore District. $N = 52$.

NOTE—DISCUSSION OF THIS PAPER IS INVITED, either for publication or for the attention of the author. Address all communications to A.S.T.M. Headquarters, 1916 Race St., Philadelphia 3, Pa.

[1] Geologist, Concrete Research Division, U. S. Waterways Experiment Station, Corps of Engineers, U. S. Army, Clinton, Miss.

[2] Standard Method of Test for Specific Gravity and Absorption of Fine Aggregate (C 128–42), 1944 Book of A.S.T.M. Standards, Part II, p. 445.

[3] Tentative Method of Test for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate (C 88 – 44 T), 1944 Book of A.S.T.M. Standards, Part II, p. 1332.

[4] Andrew Adams and Horace A. Pratt, "A Comparison of Absorption and Soundness Tests on Maine Sands," *Proceedings*, Am. Soc. Testing Mats., Vol. 45, p. 771 (1945).

[5] Before the war emergency, War Department specifications for concrete aggregate required ten cycles of the magnesium sulfate test. During the emergency, the five-cycle requirement was adopted to shorten the testing period.

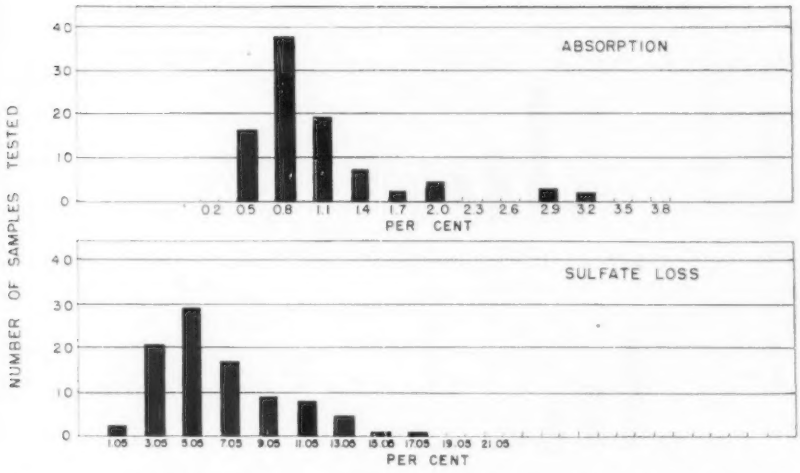


Fig. 2.—Distribution of Fine Aggregate Samples—Boston District. $N = 93$.

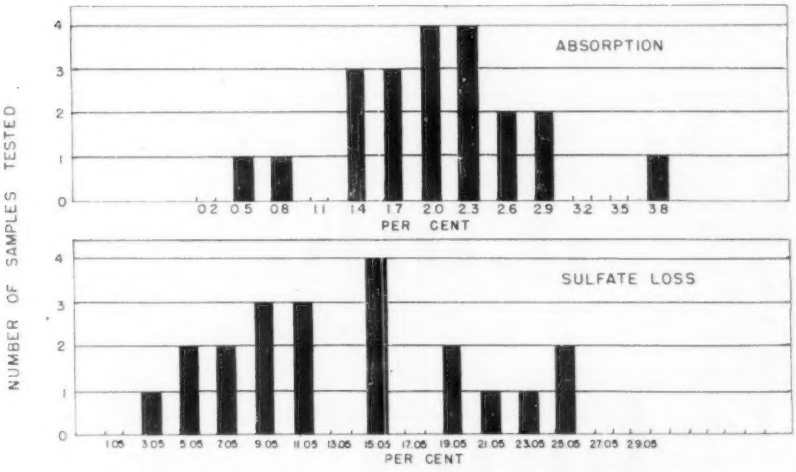


Fig. 3.—Distribution of Fine Aggregate Samples—Buffalo District. $N = 21$.

hr. in sulfate solution, the samples were dried at 105 to 110 C. for 6 to 7 hr. in an electric oven equipped with an electric blower.

As standard procedure, two runs were made on every sample submitted to the magnesium sulfate soundness test. The average of the results from the two runs was the value reported.

Prior to October 1, 1943, the percentage loss of the fraction passing No. 30 and retained on No. 50 sieve was also assigned to the fraction passing No. 50 in the original grading. Since that date, the fraction passing No. 50 has been regarded as having no loss. Results of tests made prior to October 1, 1943, were recalculated for this study to conform with present A.S.T.M. standards.

The modifications of the A.S.T.M. standard method listed above have been found useful in producing reliable and concordant results in routine testing, where both saving of time and reproducibility of results are important.

Points Analyzed Statistically:

Three of the findings of Adams and Pratt in the study of 62 Maine sands[4] were considered of especial interest and subjected to further study. The points will be taken up in order. They were:

1. The high positive correlation between absorption and loss in magnesium sulfate test ($r = +0.8056$).
2. The corollary, "the soundness of a sand with magnesium sulfate may be estimated very closely from the absorption test."[6]
3. "The grading of a sand is not significant when used statistically with the results of the absorption test for estimating the soundness."[7]

Interpretation of the Correlation Coefficient:

The *coefficient of simple linear correlation*, r, measures the degree to which observations of two factors fall on a straight line. When all the observations fall on the line, r equals $+1$ or -1; when the observations are so scattered that any line is as good as any other, r equals 0.

When the value of the correlation coefficient is known, the amount of variation in one factor due to variation in the other (*coefficient of determination*) may be found, and the error in predicting one factor from the other (*standard error of estimate*) may be found. The relation between the correlation coefficient and the coefficient of determination, and the relation between the correlation coefficient and the standard error of estimate, are not simple

[6] *Op. cit.*, conclusion 4.
[7] *Op. cit.*, p. 774.

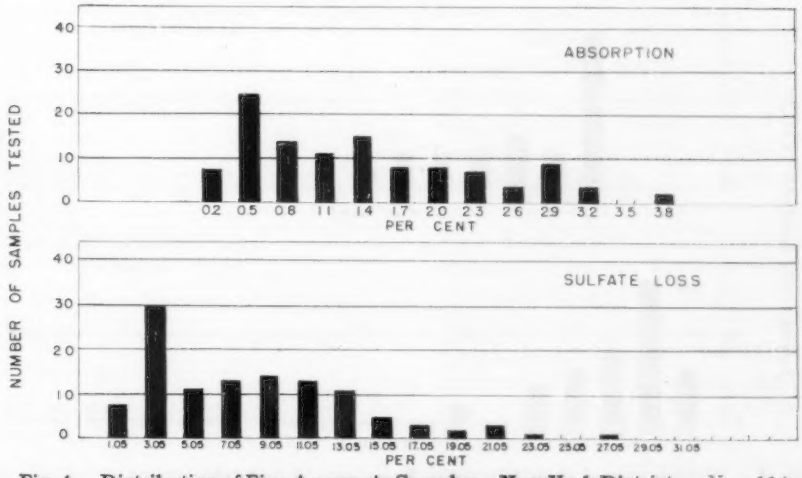


Fig. 4.—Distribution of Fine Aggregate Samples—New York District. $N = 114$.

linear relations, as Table I will indicate.

TABLE I.—RELATION BETWEEN CORRELATION COEFFICIENT, DETERMINATION COEFFICIENT AND STANDARD ERROR OF ESTIMATE.

Correlation Coefficient, r, Between a and b	Variation in a Due to Variation in b, per cent	Remaining Error in Predicting a from b, per cent
0.00	0	100.0
0.10	1	99.5
0.50	25	87.0
0.87	75	50.0
0.95	90	31.0
1.00	100	0.0

A correlation coefficient is described as "significant" when the value is a higher one than would occur by chance. The division between chance occurrence and "significance" is based on statistical probability; where the division is made is a matter of individual judgment. Correlation coefficients derived in this paper that are described as "significant" correspond to a probability of chance occurrence of 2 or less in 100; coefficients described as "surely significant" correspond to a probability of chance occurrence of 1 or less in 100.[8]

In any instance, the size of correlation coefficient necessary for "significance" depends on the number of observations from which the coefficient is calculated. As the size of sample increases, the value necessary for "significance" decreases. Thus a correlation coefficient can be "significant" without being high or useful.

[8] The test of "significance" employed was the transformation of the simple linear correlation coefficient, r, to z, and use of the standard error of z. This was preferred to the standard or the probable error of r because it is a more reliable test for small samples and high values of r. See R. A. Fisher, "Statistical Methods for Research Workers," Oliver and Boyd, Edinburgh and London (1936); also George Gaylord Simpson and Anne Roe, "Quantitative Zoology," McGraw-Hill Book Co., New York, pp. 237–242 (1939).

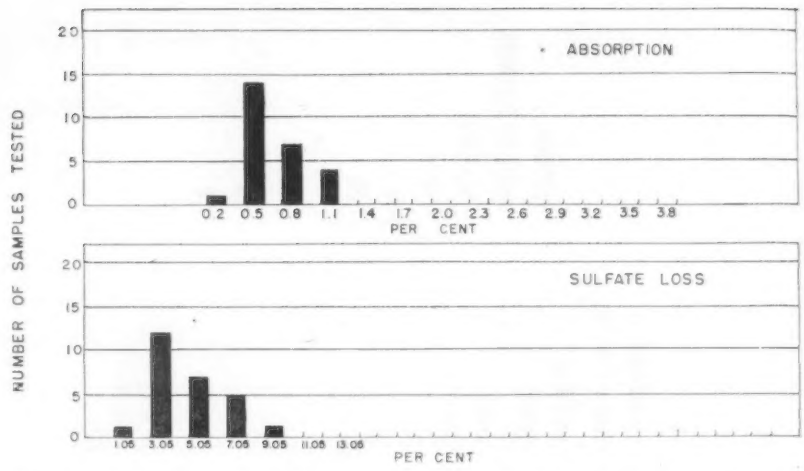


Fig. 6.—Distribution of Fine Aggregate Samples—Providence District. $N = 26$.

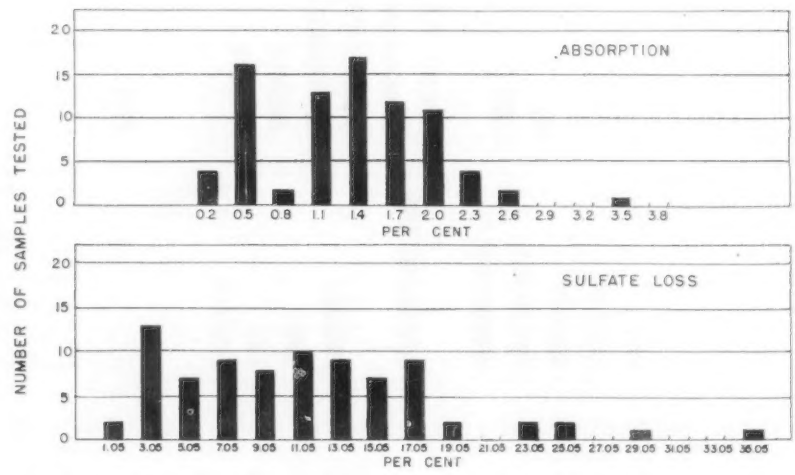


Fig. 7.—Distribution of Fine Aggregate Samples—Syracuse District. $N = 82$.

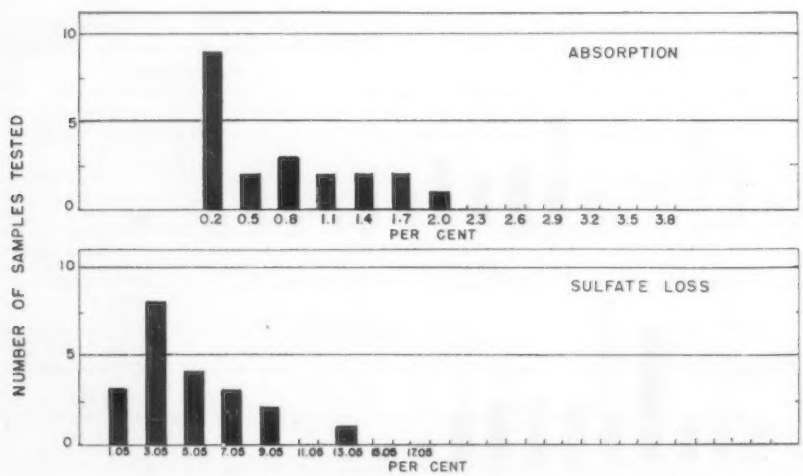


Fig. 5.—Distribution of Fine Aggregate Samples—Philadelphia District. $N = 21$.

Relation Between Absorption and Sulfate Loss:

A summary of the test data considered here is given in Table II (absorption) and Table III (magnesium sulfate losses), and Figs. 1 to 8.

To compare the relation between absorption and sulfate loss in these data with that found by Adams and Pratt, simple linear correlation coefficients were computed for each district and for all tests (Table IV).

Consideration of these correlation coefficients shows that, for the seven districts, values range from +0.302 (Providence) to +0.869 (Buffalo and New York). The Providence sample is small and shows the lowest range in absorption and sul-

TABLE II.—SUMMARY OF TEST DATA—ABSORPTION.

District	Samples Tested	Mean, per cent	Standard Deviation, per cent	Coefficient of Variation	Absorption Range, per cent
Baltimore	52	0.97	0.535	55	0.2 to 2.1
Boston	93	1.04	0.604	58	0.4 to 3.3
Buffalo	21	2.05	0.710	35	0.6 to 3.8
New York	114	1.42	0.910	64	0.1 to 3.7
Philadelphia	21	0.74	0.587	80	0.1 to 1.9
Providence	26	0.67	0.236	36	0.3 to 1.2
Syracuse	82	1.32	0.656	50	0.3 to 3.6
All data	409	1.21	0.760	63	0.1 to 3.8

fate losses of any (Tables II, III). It should also be remembered that failure to demonstrate a relation statistically does not mean that the relation does not exist. However, six out of seven districts show strong positive correlation between sulfate loss and absorption. Four (Baltimore, Buffalo, New York, Syracuse) show a higher correlation than that found for Maine sands by Adams and Pratt.

To discover how much of the variation in sulfate losses is associated with variation in absorption, the coefficient of determination[9] was computed for each group of data. This value, equal to r^2, measures the extent to which variance in sulfate losses is determined by absorption.

TABLE III.—SUMMARY OF TEST DATA—MAGNESIUM SULFATE LOSSES.

District	Samples Tested	Mean, per cent	Standard Deviation, per cent	Coefficient of Variation	Sulfate Loss, Range, per cent
Baltimore	52	5.82	3.885	67	1.4 to 16.8
Boston	93	6.45	3.181	49	1.6 to 18.0
Buffalo	21	12.96	6.839	53	3.9 to 24.5
New York	114	8.19	5.457	67	1.0 to 26.6
Philadelphia	21	4.61	3.178	69	0.2 to 13.6
Providence	26	4.49	1.915	43	1.7 to 8.6
Syracuse	82	10.88	6.589	61	1.8 to 34.2
All data	409	7.86	5.449	69	0.2 to 34.2

District	Coefficient of Determination, per cent
Baltimore	70.4
Boston	44.4
Buffalo	75.5
New York	75.4
Philadelphia	59.9
Providence	9.1
Syracuse	65.6
All data	65.0
Maine (data from Adams and Pratt)	65.0

[9] Coefficient of determination = $1 - \left(\frac{Sm^2}{SDm^2}\right) = r^2$

where:
Sm = standard error of estimate of sulfate losses (from regression),
SDm = standard deviation of sulfate losses, and
r = coefficient of simple linear correlation.
For discussion, see Albert E. Waugh, "Elements of Statistical Method," McGraw-Hill Book Co., New York, pp. 418–420 (1943).

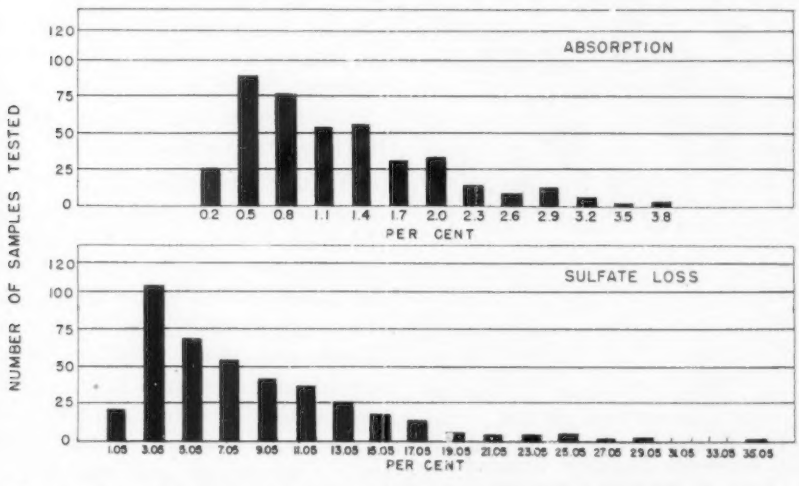


Fig. 8.—Distribution of Fine Aggregate Samples—Seven Districts. N = 409.

It is apparent that in all cases but that of Providence, variation in absorption accounts for a large part of the variation in sulfate losses. In two cases (Buffalo and New York) it accounts for a little more than 75 per cent of the total variation. The remaining variation cannot be accounted for statistically on the basis of this study, but should, logically, be due to a combination of several causes: lithological variation, nonrepresentative sampling, and errors in testing.

Prediction of Sulfate Loss from Absorption:

From the coefficients of determination shown above, it can be seen that estimates of sulfate losses based on absorption values should be fairly accurate in all cases but that of Providence. Regression equations, or equations of the lines of best fit, and the standard errors of estimate resulting from their use, are shown in Table V. The equations are plotted in Fig. 9. Inspection of the figure shows that several equations (Baltimore, Buffalo, New York, Syracuse), all of high statistical respectability, will give considerable variation in results if they are used to predict sulfate losses.

TABLE IV.—COEFFICIENTS OF SIMPLE LINEAR CORRELATION ABSORPTION *VERSUS* SULFATE LOSS.

District	Samples Tested	Correlation Coefficient, r	Significance
Baltimore	52	+0.839	Surely significant
Boston	93	+0.666	Surely significant
Buffalo	21	+0.869	Surely significant
New York	114	+0.868	Surely significant
Philadelphia	21	+0.774	Surely significant
Providence	26	+0.302	Not significant
Syracuse	82	+0.810	Surely significant
All data	409	+0.807	Surely significant
Maine (Adams and Pratt)	62	+0.806	Surely significant

In choosing among the regression equations, there are two statistical aids. One is the coefficient of determination, which led to the conclusion that the equations for Baltimore, Buffalo, New York, Syracuse, and that for all data should give more accurate results than those for Boston, Philadelphia, and Providence, since a larger percentage of the variation in sulfate losses depends on variation in absorption in those cases. Another, which leads to similar conclusions, is the reduction in range of estimated sulfate losses (the ratio of the

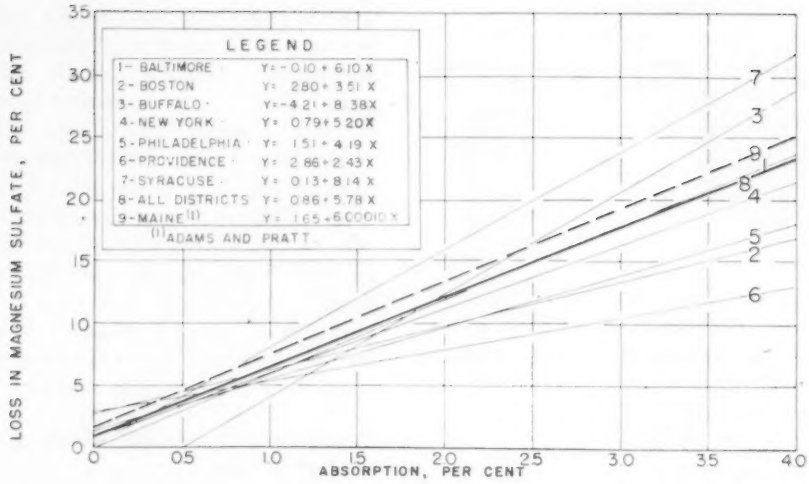


Fig. 9.—Regression Lines for Relation of Absorption to Sulfate Loss—Fine Aggregate.

standard error of estimate to the standard deviation of sulfate losses, expressed as a percentage):

District	Reduction in Range of Estimated Sulfate Losses
Baltimore	55.5
Boston	75.4
Buffalo	51.7
New York	50.0
Philadelphia	66.6
Providence	99.2
Syracuse	59.5
All data	59.3

Among the five best equations, choice depends on complex non-statistical considerations such as the lithological nature of the sands involved. The Syracuse and Buffalo groups are made up of sands in which fragments of sedimentary rock—shale and sandstone especially—are major constituents. The New York and Baltimore (also Philadelphia) groups include such sands, but the predominantly quartz and granitic sands are also very important. The Boston group includes all the constituents mentioned above, and a greater amount of schist, gneiss, and slate fragments than any of the preceding groups. Combination of all the districts will give an over-all idea of the relation between absorption and sulfate tests which may be expected in the northeastern United States, but it will not necessarily be accurate for any one suite of sands.

Figure 10[10] shows the distribution of 2031 samples of coarse and fine aggregates by absorption ranges, and the percentage of unsound samples in each range. Criteria for unsoundness were sulfate losses of more than 7 per cent at 5 cycles or more than 10 per cent at 10 cycles.

[10] Taken from C. E. Wuerpel, "Aggregates for Concrete," Open Forum on Plant Processing Methods, Circular 25, Nat. Sand and Gravel Assn., p. 12 (1944).

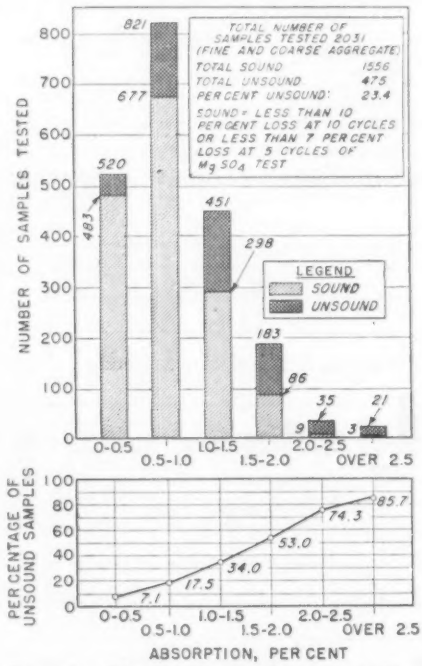


Fig. 10.—Distribution of Sound and Unsound Aggregate Samples Grouped on Basis of per cent Absorption.

* See Footnote 9.

In the range from 1.5 to 2.0 per cent absorption, all of the regression equations of Fig. 9 but that for Providence would predict sulfate losses of more than 7 per cent at 5 cycles; Fig. 10 shows that 47 per cent of such aggregates are sound. Even in the range from 2.0 to 2.5 per cent absorption, 25.7 per cent of the aggregates are sound on the basis of these criteria. Statistical prediction is of necessity prediction for over-all behavior, not for behavior in individual cases. It is the individual cases—specific aggregates for specific uses—that consumers and producers are both concerned with.

TABLE V.—REGRESSION EQUATIONS ESTIMATES OF SULFATE LOSS FROM ABSORPTION.

District	Regression Equation	Standard Error of Estimate of Sulfate Loss
Baltimore	$Y = -0.10 + 6.10X$	2.16
Boston	$Y = 2.80 + 3.51X$	2.40
Buffalo	$Y = -4.21 + 8.38X$	3.54
New York	$Y = 0.79 + 5.20X$	2.74
Philadelphia	$Y = 1.51 + 4.19X$	2.12
Providence	$Y = 2.86 + 2.43X$	1.90
Syracuse	$Y = 0.13 + 8.14X$	3.92
All data	$Y = 0.86 + 5.78X$	3.23
Maine (Adams and Pratt)	$Y = 1.65 + 6.0010X$	2.8093

where:
Y = estimated sulfate loss in per cent, and
X = absorption in per cent.

Relation Between Sulfate Loss and Per Cent Passing No. 50 Sieve:

In the study of Maine sands the correlation between sulfate loss and percentage passing No. 50 sieve and the correlation between sulfate loss and percentage passing No. 100 sieve were low, but the probability of chance occurrence in a sample of 62 was less than two in 100, so they were considered significant. However, in the multiple correlation of sulfate losses with absorption, percentage passing No. 50, and percentage passing No. 100, it was demonstrated that the two grading factors were not significant.

In the present study it was anticipated that a higher correlation between cumulative percentage passing No. 50 and sulfate loss might be found since a larger sample than the one available to Adams and Pratt was used. Further, it was anticipated that in a larger sample, the multiple correlation of sulfate losses with absorption and cumulative percentage passing No. 50 sieve might account for more of the

variation in sulfate losses than either simple correlation. To get the largest possible representation, data from all districts were included (409 tests).

Multiple correlation involving three or more factors is a measure of the association between a dependent factor (arbitrarily chosen) and the other factors, where all vary. *Partial correlation* involving three or more factors is a measure of the association between any two, with the others held constant. The mechanics of both multiple and partial correlation necessitate the computation of simple correlation coefficients between each pair of factors included. Simple, multiple, and partial correlation coefficients in the relation: sulfate loss, absorption, and cumulative percentage passing No. 50 sieve, are shown below:

Simple Correlation Coefficients—All Data (409 Samples)

Sulfate loss *versus* absorption: $r = +0.8065$ (surely significant)

Sulfate loss *versus* cumulative percentage passing No. 50 sieve: $r = -0.1780$ (surely significant)

Absorption *versus* cumulative percentage passing No. 50 sieve: $r = -0.1342$ (surely significant)

Multiple Correlation Coefficient

Sulfate loss *versus* absorption and cumulative percentage passing No. 50 sieve: $R = 0.8096$ (surely significant)

Partial Correlation Coefficients

Sulfate loss *versus* absorption, cumulative percentage passing No. 50 sieve constant: $r = +0.8026$ (surely significant)

Sulfate loss *versus* cumulative percentage passing No. 50 sieve, absorption constant: $r = -0.1191$ (significant)

Absorption *versus* cumulative percentage No. 50 sieve, sulfate loss constant: $r = +0.0162$ (not significant)

The simple and partial correlations between sulfate loss and cumulative percentage passing No. 50 sieve confirm the low but significant correlations found by Adams and Pratt. The coefficient of determination, r^2, shows that only 3.2 per cent of the variation in sulfate loss can be explained by variation in cumulative percentage passing No. 50 sieve, so the fact can be of little use in estimating sulfate loss. The work of Adams and Pratt is supported by the multiple correlation, which shows a very slight improvement over the simple correlation of absorption and sulfate loss. The apparent association of absorption and cumulative percentage passing No. 50 sieve is reduced to insignificance when the influence of sulfate loss is removed.

Consideration of these data therefore confirms Adams and Pratt's finding that the grading of a sand is not significant when used *statistically* with the results of the absorption test for estimating sulfate losses. In individual cases and within single deposits, however, the influence of grading on sulfate test results can be most important. Samples of one sand in two gradings have repeatedly been tested in this laboratory. Samples of this sand with the grading of concrete sand consistently show higher losses in the magnesium sulfate test than the specifications allow; samples with the larger sizes removed to meet the grading of masonry sand satisfy the same specifications. This effect is brought about by two causes: first, the individual loss by the larger fractions (retained on Nos. 4, 8, and 16 sieves) is almost invariably higher than the loss by the fractions retained on No. 30 and No. 50 sieves; second, within the limits permitted by any grading specification, an increase in cumulative percentage passing No. 50 sieve means a decrease in the percentage to which loss can be assigned in the calculation of results, since this fraction finer than No. 50 sieve is not tested and is assigned 0 per cent loss.

Conclusions

Statistical analysis of absorption and magnesium sulfate test values for 409 samples of sand from the northeastern United States has shown that:

1. In the region considered, a high correlation exists between values obtained from these two tests. The strength of the correlation varies from area to area within this region.

2. In the region as a whole, 60 to 65 per cent of the variation in sulfate test results is attributable to variation in absorption.

3. The relation between these two types of data, expressed as a regression equation, can be used to estimate sulfate loss. Reliability of the estimate will depend on the comparability of the sand which is the subject of prediction to the suite of sands on which the prediction is based.

4. Use of the general relation, sulfate loss $= 0.86 + 5.78a$, where a = percentage absorption, will indicate sulfate losses of 7 per cent or greater for all absorption values of 1.06 per cent or more. Since many aggregates with absorption values above 1.06 per cent have shown less than 7 per cent loss in the sulfate test, this relationship cannot be used as an acceptance criterion for a specific material. It should be noted that *statistical* prediction is prediction for over-all behavior, not for behavior in individual cases. It is the individual cases—specific aggregates for specific uses—that consumers and producers are both concerned with.

5. The variation in amount passing No. 50 sieve in a sand is not statistically significant in affecting the relation between absorption and loss in the magnesium sulfate test. This lack of statistical significance is not to be interpreted as meaning that the value for sulfate loss obtained by testing a given sand will remain constant as the grading varies.

Ten Years' Outdoor Exposure of Filled Asphalt Coatings on Saturated Felts*

By G. L. Oliensis[1]

SYNOPSIS

Past exposure tests on filled coatings have been made on small, rigid aluminum panels, usually in the Weatherometer for relatively short periods, and have indicated that nearly all fillers improve the weatherability of asphalt, some fillers more than others.

The author has exposed coatings outdoors on asphalt-saturated felt for approximately ten years. These tests indicate that fillers do stabilize the flow and thereby improve the life of roofing cements of relatively low softening point, which have a tendency to flow or sag when unfilled; but that fillers do not seem to improve the crack resistance of coatings of higher softening point which do not flow when unfilled.

IN THE summer of 1935 the author spent a month in the southern states studying the widely varying patterns of "alligatoring," checking, and cracking shown by the different types of asphalt used in built-up roofs after different periods of exposure, as well as the marked differences in those patterns in any one asphalt due to differences in layer thickness alone. For example, invariably as the layer suddenly thickened, the cracks would as suddenly grow correspondingly wider, deeper, and farther apart; and as the layer thinned out abruptly, the cracks would as abruptly grow correspondingly finer and narrower and closer together (see Figs. 1 and 2). The author was also impressed, on the one hand, by the total absence of flow in some asphalts and, on the other hand, by the alternating cycles of accelerated and retarded flow, and of alternating checking and self-healing, that developed in other asphalts at different seasons of the year and at different exposure ages, and that left their permanent imprint on the surface of the roofing much as the tree presents a record of its growth in the rings of its trunk (see Figs. 2 and 3).

Also noticeable was very clear evidence of the cracking stresses exerted on both the bituminous coat-

NOTE—DISCUSSION OF THIS PAPER IS INVITED, either for publication or for the attention of the author. Address all communications to A. S. T. M. Headquarters, 1916 Race St., Philadelphia 3, Pa.

* Presented at the Forty-Ninth Annual Meeting, Am. Soc. Testing Mats., Buffalo, N. Y., June 24-28, 1946.

[1] Director of Research, Lloyd A. Fry Roofing Co., Madison, Ill.

Fig 1.

Fig 2.

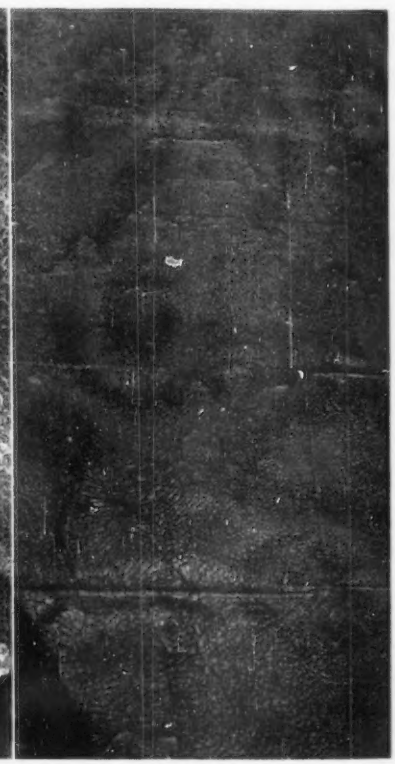


Fig 3.

ing and the felts by wind and vibration (especially in cold weather when the pliability of a bituminous roof is at its minimum); and the stretching and blister-inducing effects of trapped and slowly vaporizing moisture (especially in hot weather when the limpness and tenderness of bituminous roofing is at its maximum); and the destructive torques exerted by the edges or corners of warped, or bulging, or swaying roofboards, or by the roof deck's failure to supply adequate support.

Weatherometer Tests on Coatings *versus* Outdoor Exposure of Actual Roofings

A comprehensive series of exposure tests to study these weathering reactions in a more methodical and comprehensive manner appeared highly desirable. For this purpose the Weatherometer might have seemed the logical apparatus; but while tests therewith have an undoubted value, it was concluded that since in that instrument the films of asphalt are applied on small, rigid aluminum panels and subjected repeatedly to the same unvarying cycles of brief hot and cold, wet and dry periods, the Weatherometer could not in the nature of things be expected very closely to simulate weather conditions prevailing in the great outdoors. For asphalt in actual roofing service is applied, not on a rigid and vibration-free metal surface, but on a flexible, yielding and (in a storm) swaying, twisting, and quivering felt base, where it is subjected both to much more extreme ranges of temperature and to much longer and more violently fluctuating cycles of weather, than prevails in the Weatherometer; for it may have to lie for weeks or months baking in the full glare of the midsummer sun, or rigidly encased in an alternately expanding and contracting sheet of solid ice, or weltering in shallow pools of water or slush.

The same reflections were amplified by the author some eight years later, in his discussion of a paper presented at an Annual Meeting of this Society.[2] In that discussion, he said in part:

> "There are two rather important factors that are not sufficiently taken into consideration in construing them [Weatherometer tests], and yet which do markedly affect weathering resistance. One of these factors...is...wind stresses and vibration, which may open up numerous "hair-cracks" in the coating layer, especially during the winter season when the roofing is more or less brittle.... No matter how inherently sound a coating may be...if vibration...should crack that coating and thus expose the bare saturated felt to the weather, fairly quick disintegration is quite likely....
>
> "There is another factor that is probably of equal importance: In the Weatherometer the coatings are applied upon aluminum panels;...yet in actual service, they are applied usually on asphalt-saturated felt or other similar fabrics, and I am convinced that there is a big difference in the behavior of asphalts on metal and their behavior on fabrics that have been impregnated with asphalts."

Last fall, a somewhat similar point of view was presented by no less an authority than Mr. Kettering,[3] who explained how inconclusive certain exposure tests on paint panels at Coral Gables, Fla., had proved to be, until it had been discovered that, contrary to expectations, it was not the intense heat nor the ultraviolet rays of the sun that did the most damage to the panels, nor was it moisture nor air, but a certain combination of particular phases of each of these and other unanticipated factors for which no provision could well have been made in the usual weathering apparatus. The first link in the destructive chain of reactions had been, to be sure, the baking effect of the hot sun that hardened the film and thus destroyed its power to expand and contract as fast as the metal itself, as a result of which the film had finally cracked open. That alone, however, would have been only potentially harmful. Moisture, too, the second factor, was necessary; but again, not any kind of moisture would have been effective—not rain, for instance, nor a spray; for these (as could be surmised from Mr. Kettering's remarks) would have tended to wash away from the haircracks the minute deposits of salt, a third factor, that lay there for the moment more or less inert. Instead, the real activating agent for the destructive chain of reactions was, unexpectedly enough, plain dew, which ordinarily would have appeared perfectly harmless, but which by virtue of its very mildness proved the panel's undoing; for being too gentle to wash off or even disturb those electrolytic salts, as rain or sprays would have so readily done, it merely kept them just sufficiently moistened to start them actively on their corrosive career. This illustrates how intricate are the combinations of factors that nature contrives to undermine our works, and how hopeless a task it must sometimes be to figure out in advance a set of arbitrary conditions and exposure cycles in a man-made apparatus like the Weatherometer, that would duplicate all the possible conditions involved in actual weathering, and, finally, how seriously we may sometimes be misled by weathering tests on materials if obtained in any other way than as in actual service.

Preparation and Mounting of Exposure Panels

It was substantially such considerations as the foregoing that prompted us, in the summer of 1935, to prepare our series of outdoor exposure tests on panels composed, not of metal, but of a layer of asphalt-saturated felt, over which was spread a coating or film of a large number of different roofing asphalts—filled and unfilled, fluxed native asphalt and petroleum asphalt, both of the relatively low softening-point type such as used for hot-mopping in built-up roof construction, and of the relatively high softening-point type employed in the manufacture of ready-prepared roofing. To permit of about the same freedom of movement in these panels as can be anticipated on a regular built-up roof, it was decided not to nail but to cement these panels to the old and rather badly worn and cracked asphalt roof of an old warehouse at our Madison, Ill., plant.

In constructing these panels, a piece of No. 15 asphalt-saturated rag felt, about 14 by 14 in., was placed flat on a smooth heavy steel

[2] Bruce Weetman, "Accelerated Weathering of Bituminous Material—Effect of Operating Variables," *Proceedings*, Am. Soc. Testing Mats., Vol. 43, p. 1154 (1943).

[3] C. F. Kettering, "Address," A.S.T.M. Bulletin, No. 137, December, 1945, p. 15.

plate, the edges of the felt being fastened down between two machined steel bars, 1 in. thick, bolted into the plate, one on each side. The asphalt was kept melted at a low temperature until smooth and free from foam, then poured over this sheet of saturated felt and quickly smoothed out with a previously heated sharp-edged steel doctor blade, whose two ends or handles rested on the two metal side supports, and whose lower or knife edge, for the entire distance between these two supports, had a clearance of 0.040 to 0.045 in. (roughly equivalent to a layer of 25 lb. of asphalt per 100 sq. ft.) above the top surface of the felt. After cooling, the sheet was trimmed to approximately a square-foot size and was cemented to the old asphalt roof deck previously referred to by means of an asphalt plastic cement troweled out over the roof in a continuous layer about $\frac{1}{16}$ in. thick, after which the sheet or panel was pressed smoothly into that layer, additional plastic cement was worked up against the four edges of the felt, so as to prevent rain or surface moisture from penetrating under the latter or into the saturated sheet forming its base.

The primary object of this series of tests was, of course, to study methodically and from their inception, the periodic cycles of flow, surface-wrinkling and self-healing, and the patterns of checking and cracking, of these widely different asphalts when exposed side by side on the same roof.

In the summer of 1938, another group of panels was prepared, similarly constructed and cemented to the old warehouse roof deck at Madison, though the primary object of the exposure of the later group was more concrete than that of the earlier one—namely, to determine how the improvement in weathering resistance imparted to coatings by a few new types of filler that were then under consideration would compare with that of a filler that we had been employing successfully until then.

In order to make this comparison as reliable as possible, most of the mixtures of asphalt and filler were prepared in the laboratory, using 67 per cent by weight of the former and 33 per cent of the latter, and following the same compounding procedure in each case—that is, always maintaining the mixture at the lowest possible temperature compatible with satisfactory fluidity, and only long enough to dissipate the foaminess completely and yield a smooth, homogeneous blend. A panel, or sheet of saturated felt, coated with the unfilled asphalt, was included with each set of panels coated with the blends of that asphalt with filler.

Discussion

A total of 24 panels, from both the 1935 and the 1938 groups, is discussed in this paper. A brief description of the 24 is found in Table I, from which it will be noted that there are included asphalts from four different sources (Arkansas, Texas, Texas-Venezuelan, and Venezuelan); from three different manufacturing processes: (*a*) straight vacuum-reduced (of about 40 penetration and over 100-cm. ductility), (*b*) partly vacuum-reduced and partly air-blown (of the type sometimes referred to as semi-blown, and of about 30 penetration, 150 F. softening point and over 10-cm. ductility), and (*c*) fully air-blown asphalt (of about 20 penetration, 210 F. softening point and 3-cm. ductility). It will also be noted that the panels have been about equally divided between coatings of unfilled and filled asphalt, containing five different types of filler constituting between 33 and 38 per cent of the weight of the filled asphalt; and finally, that these panels have been exposed to the weather for between 7.5 and 10.5 yr.

Table II gives a detailed description of the five fillers used. These fillers were all of rather fine grading, ranging from 89 to 97 per cent passing the No. 200 sieve, and came from five different sources—dolomite, limestone, oyster shell, green

TABLE I.—CHARACTERISTICS AND COMPOSITION OF COATINGS APPLIED ON 24 MADISON PANELS.[a]

Line	Panel	Character of Coating	Type of Asphalt			Tests on Coating				Filler		Thickness of Coating, in.	Years Exposed
			Source	Method of Refining	Grade	Penetration at 77 F.	Softening Point, deg. Fahr.	Ductility at 77 F., cm.	Specific Gravity at 60 F.	Type	Percentage in Coating		
1..	No. 1	Unfilled	Arkansas	Vacuum-reduced	...	40	133	100+	1.033	None	...	0.035	7.5
2..	1(*a*)	Filled	Arkansas	Vacuum-reduced	...	31	145	...	1.328	D	36.0	0.043	7.5
3..	No. 2	Unfilled	Arkansas	Semi-blown[b]	...	32	152	11	1.029	None	...	0.030	7.5
4..	No. 2(*a*)	Filled	Arkansas	Semi-blown[b]	...	23	170	...	1.324	D	36.0	0.037	7.5
5..	No. 2(*b*)	Filled	Arkansas	Semi-blown[b]	...	23	166	...	(1.323)	C	36.0	0.038	7.5
6..	No. 3	Unfilled	Venezuelan	Semi-blown[b]	...	28	154	(10)	1.031	None	...	0.046	7.5
7..	No. 3(*a*)	Filled	Venezuelan	Semi-blown[b]	...	21	168	...	1.326	D	36.0	0.040	7.5
8..	No. 4	Unfilled	Arkansas	Fully air-blown	...	23	204	2.5	1.060	None	...	0.054	5 and 10.5
9..	No. 4H	Unfilled heat-treated	Arkansas	Fully air-blown	...	19	210	...	(1.063)	None	...	0.061	5 and 10.5
10..	No. 4(*a*)	Filled	Arkansas	Fully air-blown	...	18	212	1.8	1.320	A	34.2	0.042	5 and 10.5
11..	No. 5	Unfilled	Arkansas	Fully air-blown	(G)	21	202	2.7	1.060	None	...	...	7.5
12..	No. 5(*a*)	Filled	Arkansas	Fully air-blown	(G)	18	214	1.3	1.325	D	33.0	...	7.5
13..	No. 5(*b*)	Filled	Arkansas	Fully air-blown	(G)	19	209	...	...	C	33.0	...	7.5
14..	No. 5(*c*)	Filled	Arkansas	Fully air-blown	(G)	19	211	...	...	B	33.0	...	7.5
15..	No. 6	Unfilled	Arkansas	Fully air-blown	(U)	23	202	2.6	1.028	None	...	...	7.5
16..	No. 6(*a*)	Filled	Arkansas	Fully air-blown	(U)	19	213	1.4	1.355	D	38.2	...	7.5
17..	No. 7	Unfilled	Texas	Fully air-blown	(G)	21	207	(2.5)	1.078	None	...	...	7.5
18..	No. 7(*a*)	Filled	Texas	Fully air-blown	(G)	18	216	(1.5)	1.342	D	35.0	...	7.5
19..	No. 8	Unfilled	Texas	Fully air-blown	(U)	23	205	(2.5)	1.037	None	...	...	7.5
20..	No. 8(*a*)	Filled	Texas	Fully air-blown	(U)	20	217	(1.5)	1.329	D	38.1	...	7.5
21..	No. 9	Unfilled	Texas-Venezuelan	Fully air-blown	(G)	23	216	2.6	1.060	None	...	0.041	7.5
22..	No. 9(*a*)	Filled	Texas-Venezuelan	Fully air-blown	(G)	18	225	1.4	1.35	E	(33.0)	0.039	7.5
23..	No. 10	Unfilled	Texas-Venezuelan	Fully air-blown	(U)	23	218	2.7	1.030	None	...	0.047	7.5
24..	No. 10(*a*)	Filled	Texas-Venezuelan	Fully air-blown	(U)	19	228	1.3	1.360	E	(38.0)	0.049	7.5

[a] Figures in parentheses are estimated.
[b] Vacuum-reduced and partially air-blown.

TABLE II.—FILLERS IN COATINGS APPLIED ON 24 MADISON PANELS.

Type of Filler		A		B		C		D		E	
Source of Filler		Dolomite		Limestone		Oyster Shell[a]		Green Slate		Peach Bottom Blue Black Slate	
Percentage Passing Sieve	Percentage Retained on Sieve										
50 micron (No. 300)		83.0		73.0		...		91.5		96.7	
74 micron (No. 200)	50 micron (No. 300)	14.1	97.1	15.7	88.7	80.5	80.5	7.0	98.5	2.4	99.1
149 micron (No. 100)	74 micron (No. 200)	2.8		9.5		17.2		1.5		0.9	
297 micron (No. 50)	149 micron (No. 100)	0.1	2.9	1.8	11.3	2.3	19.5	...	1.5	...	0.9
Total		100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Specific Gravity at 60 F.		...		2.70		....		2.76		2.89	
Weight, lb. per cu. ft.											
Uncompacted		64.0		64.6		42.1		35.4		34.6	
Compacted		108.5		107.8		84.2		77.1		72.0	
The foregoing products correspond to the following fillers enumerated in Table 2 of Strieter's Report:[4]		Dolomite No. 2		Limestone No. 4		....		Slate Flour No. 1		Peach Bottom Slate Flour No. 16	

[a] The powdered oyster-shell filler consisted mainly of jagged, needle-like particles.

slate, and blue-black slate. Four of these five (that is, all but the oyster shell) roughly correspond in source and grading to four of the more commonly used of the 19 fillers listed in Strieter's[4] exhaustive report on a similar weathering study; and as a matter of interest there is shown at the foot of Table II which of the fillers discussed in Strieter's report correspond to the four in ours.

Weathering Behavior of Fully Air-Blown Asphalts

In his investigation, Strieter had adopted the plan of adding just enough softer asphalt to those coatings in which filler was to be incorporated, so that the filled coatings would still have the same softening point as the unfilled. In that way he was able to eliminate from his exposure studies those factors that might have been introduced if the filled coatings had had a substantially higher softening point, and correspondingly harder consistency, than the unfilled at the start.

In our own blends we did not follow that plan, but used the same asphalt both in the unfilled and filled state, so that the latter could be expected to be slightly harder and higher in softening point than the former. However, in our first set of panels exposed in 1935 (Table I, lines 8, 9, and 10), we did attain about the same effect as Strieter had done, through the expedient of dividing the unfilled coating into three portions and preparing each for the test as follows:

	Applied on Panel	Line in Table I	Treatment of Asphalt Before Application	Penetration at 77 F.	Softening Point, deg. Fahr.
First Portion	No. 4	No. 8	Original unfilled asphalt	23	204
Second Portion	No. 4H	No. 9	Same unfilled asphalt, heated 7 hr. at 400 F.	19	210
Third Portion	No. 4(a)	No. 10	Original unfilled asphalt, 65.7 per cent, dolomite filler A, 34.3	18	212

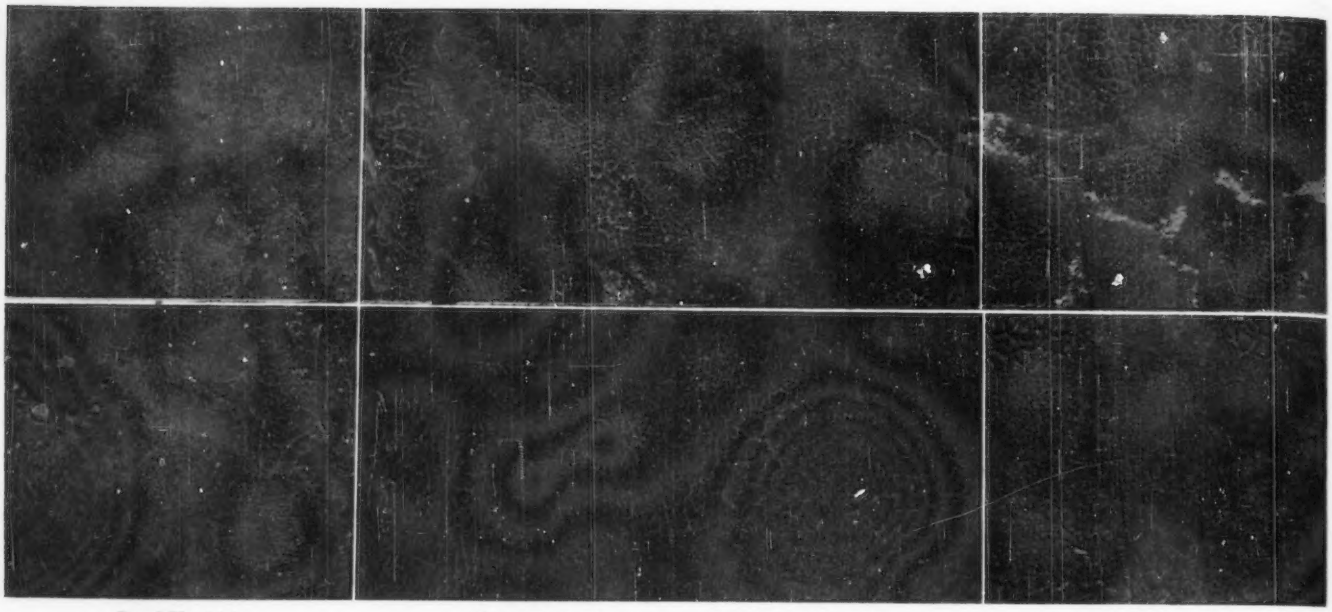
From the foregoing data it will be seen that instead of softening the unfilled coating with a softer asphalt before adding the filler, so that the filled and unfilled asphalts would be equally soft, we hardened the unfilled asphalt by 7-hr. heating at 400 F. so that the filled and unfilled asphalts would be equally hard. Of course, in subjecting the unfilled coating to this long heating process, even though done with constant stirring and care to avoid local overheating, there was the risk of impairing to some extent the coating's subsequent chances for a normal showing against its filled counterpart. Nevertheless, since the original unheated and unfilled coating was being included as a blank, it was felt that the behavior of the latter would permit of due allowance being made, if that became necessary, for any adverse effects of the heating treatment.

Fortunately, the weathering behavior of the heated asphalt proved to be, in general, sufficiently close to that of the original material to make such allowances unnecessary. Surprisingly enough, however, a careful comparison during the ensuing years of the pattern of checks and cracks on all the three panels disclosed no appreciably poorer performance on the part of either of the two unfilled materials in comparison with the filled coating. This was the more unexpected, as we had been impressed in the past with the uniformly better showing of the filled asphalt as compared with the unfilled in the Weatherometer, as well as with the uniformly greater toughness of the former as compared with the latter when tested either in briquet form for impact resistance at low temperatures, or in the finished shingle form for shatterability by slamming at normal temperatures. Under the circumstances, we could not help concluding at the time that any points of superiority that the filled coating should rightfully have shown might have become masked in our exposure test by such untoward factors, for example, as the unavoidable differences in layer thickness that we had introduced in the coatings on our panels, and the marked effect that such differences do have upon the appearance and pattern (or size and frequency) of the cracks, as briefly explained in the opening paragraph of this paper.

Consequently, when in the summer of 1938 the second series of panels was started, in which many more unfilled and filled asphalts

[4] O. G. Strieter, "Weathering Tests on Filled Coating Asphalts," *Journal of Research*, Nat. Bureau Standards, Vol. 20, p. 163 (1938). (*RP* 1073)

Panel No. 1 | Unfilled Panel No. 2 | Panel No. 3



Panel No. 1(*a*) | Panel No. 2 (*b*) | Panel No. 2(*a*) | Panel No. 3(*a*)

Filled

Panel	No. 1	No. 1(*a*)	No. 2	No. 2(*a*)	No. 2(*b*)	No. 3	No. 3(*a*)
Asphalt							
Type	Vacuum-reduced		Vacuum-reduced and slightly air-blown			Vacuum-reduced and slightly air-blown	
Source	Arkansas		Arkansas			Venezuelan	
Penetration at 77 F	40	31	32	23	23	28	21
Melting point, deg. Fahr	133	145	152	170	166	159	168
Ductility, cm	100+	...	11.0	...	...	(10.)	...
Specific gravity at 60 F	1.033	1.328	1.029	1.324	(1.323)	1.031	1.326
Filler							
Type	...	D	...	D	C	...	D
Per cent by weight	...	36.0	...	36.0	36.0	...	36.0
Coating thickness, in	0.035	0.043	0.030	0.037	0.038	0.046	0.040
Exposure, yr	7.5	7.5	7.5	7.5	7.5	7.5	7.5

were being included, we still had no doubt but that the average performance of our samples would point to the definite superiority of the filled over the unfilled, and we therefore intended at the time to concentrate mainly on a study of the relative merits of the various fillers in the filled coatings only.

It will therefore be interesting to quote from our progress reports on these panels in chronological order, since these reflect the slowly dawning realization that the unfilled coatings were in many cases apparently holding their own against the filled.

From our first report, dated June 23, 1939, a little over a year after the 1938 series of panels had been exposed, we quote as follows, italicizing the passages that refer to the favorable showing of the unfilled asphalts:

"As could be expected, no action was observable till about March of this year. . . In studying the fully air-blown asphalts, it was observed that the two unfilled Texas-Venezuelan coatings cracked much more markedly than the four unfilled mid-Continent coatings, though the filled Texas-Venezuelan coatings appeared to show less cracking than those same mid-Continents. All the mid-Continents showed very fine hair-cracks, too fine to be readily discernible except under a magnifying glass; but *what appeared significant was that the hair-cracks in those of them that were filled were not appreciably better than in those that were unfilled*, except in the case of the one filled with powdered oyster-shell filler, where the hair-cracks seem to be less pronounced than with the other fillers.

". . . . During the interval between the end of March and the present time, the trends already described have been accentuated. It is now quite clear to the naked eye that the unfilled Texas-Venezuelan coatings are cracked the worst of the entire series, and that the same coatings filled with the blue-black slate flour (filler E) have cracked the least, while the mid-Continent coatings, both unfilled and filled, occupy an intermediate position, the hair-cracks showing as merely hair-lines on the surface to the naked eye, though under a magnification of two or three diameters many of these hair checks are found to be definitely open. What to our mind is particularly significant is that while the blue-black slate flour appears to have markedly improved the resistance of the Texas-Venezuelan coatings to cracking, *the various fillers we have used with the mid-Continent coatings do not appear to have reduced substantially the amount of cracking or checking* in the latter.

". . . On the photographs just taken, the finer hair-cracks in the mid-Continents are not so readily visible to the naked eye, but a hand-magnifying glass reveals. . . that there is not much choice in general appearance as between the green slate dust and the limestone, and that in fact *none of those three fillers (except perhaps the oyster-shell) shows a measurable reduction in the extent of hair-checking in comparison with the unfilled coatings.*"

On November 19, 1941, more than three years after our second series of panels had been exposed,

a further report was made on them reading as follows:

"In 1939, certain significant trends in these panels were pointed out—namely, that the two Texas-Venezuelan unfilled coatings were the worst cracked of the lot, the two filled Texas-Venezuelan coatings were the least cracked, while the mid-Continent coatings were all intermediate between the two extremes—that is, all were very much like each other, with *apparently no substantial difference between the unfilled and the filled coatings.*

"During the past year, however, the two filled Texas-Venezuelan coatings that had held up so well previously began to fail rapidly, developing numerous deep, long cracks which made them, in my opinion, rank worse (rather than better) than the mid-Continent filled coatings.... According to the Weatherometer, the mid-Continent filled coatings should roughly be twice as durable as the unfilled. Yet *the outdoor exposure panels, after three years, still indicate the filled and the unfilled mid-Continents are about the same.*"

The foregoing comments show clearly the gradual crystallization of the thought in the author's mind that, contrary to their showing by the impact test at 32 F., by the slam test of shingles coated with them at room temperature, and by their Weatherometer test on aluminum panels, unfilled coatings, when exposed to actual weathering conditions on a roofing sheet on an actual roof deck, may not always suffer by comparison with their filled counterpart.

During the subsequent war years, only cursory inspections were made of these panels. The general impression gained from those random inspections, however, remained as before, that the filled Texas-Venezuelan coatings, which had started to fail abruptly between the second and third years, were breaking down rapidly, and that the filled mid-Continent coatings, while not much different from the unfilled, were if anything developing somewhat wider and deeper (though somewhat more widely spaced) cracks than the unfilled.

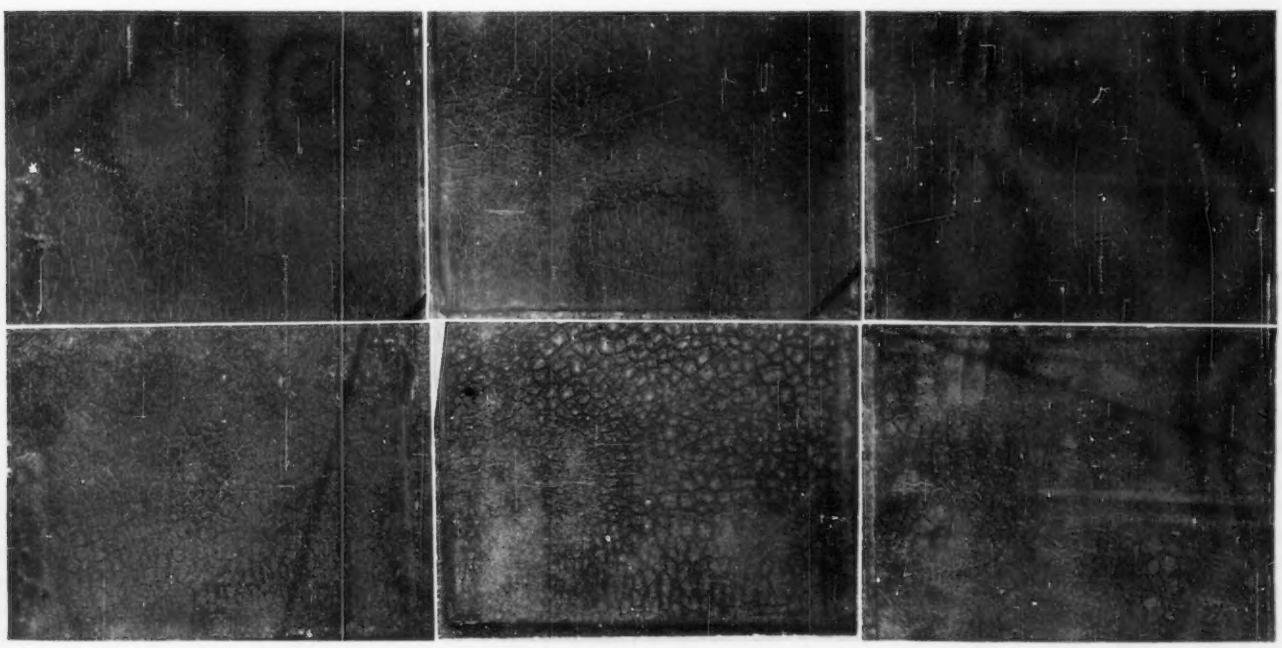
However, it was not until this past fall, after the first series of panels had been exposed for 10.5 yr. and the second series for 7.5 yr., that they were all given another really thorough inspection and again photographed. These recent photographs are shown in the accompanying panels Nos. 1 to 10, inclusive, supplemented in the case of the earlier group (namely, the No. 4 series) by the photographs taken after 5-yr. exposure.

Referring first to the No. 4 series of panels, and taking as our standard of comparison the cracks in the original unfilled coating shown on the left (panel No. 4), we note that in contrast the cracks in the heat-hardened coating shown in the center (panel No. 4H) are deeper but farther apart, while those in the filled coating shown on the right (panel No. 4(*a*)) are in

Panel No. 4
Unfilled

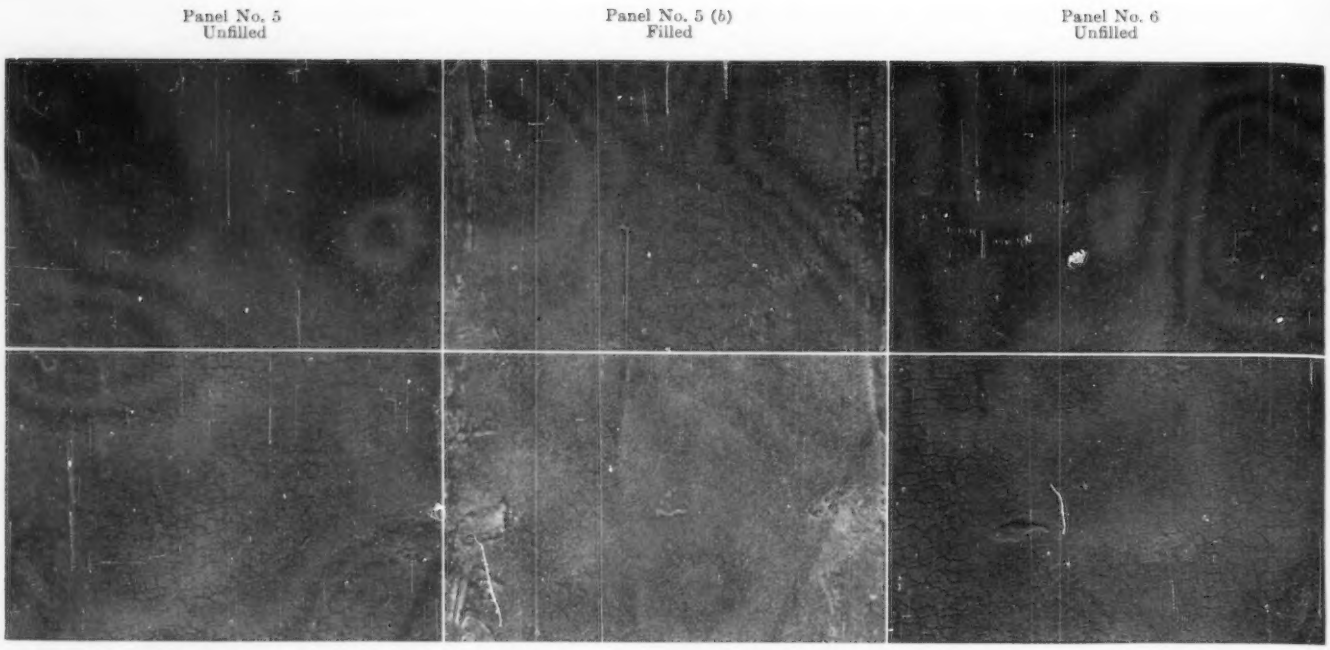
Panel No. 4H
Unfilled

Panel No. 4 (*a*)
Filled



Top Row—Exposed 5 yr.
Bottom Row—Exposed 10½ yr.

Panel	No. 4	No. 4H Heat-hardened (after 7 hr. at 400 F.)	No. 4(*a*)
Asphalt			
Type		Fully air-blown	
Source		Arkansas	
Penetration at 77 F.	23	19	18
Melting point, deg. Fahr.	204	210	212
Ductility, cm.	2.5	...	1.8
Specific gravity at 60 F.	1.060	(1.063)	1.320
Filler			
Type	...	...	A
Per cent by weight	...	...	34.3
Coating thickness, in.	0.054	0.061	0.042



Panel	No. 5	No. 5(a)	No. 5(b)	No. 5(c)	No. 6	No. 6(a)
Asphalt	Grade G Fully air-blown Arkansas				Grade U Fully air-blown Arkansas	
Type						
Source						
Penetration at 77 F.	21	18	19	19	23	19
Melting point, deg. Fahr.	202	214	209	211	202	213
Ductility, cm.	2.7	1.3	...	...	2.6	1.4
Specific gravity at 60 F.	1.06	1.325	...	1.32	1.028	1.355
Filler						
Type	...	D	C	B	...	D
Per cent by weight	...	33.0	* 33.0	33.0	...	38.2
Coating thickness, in.	...	...	...	...	...	...
Exposure, yr.	7.5	7.5	7.5	7.5	7.5	7.5

some areas still deeper and farther apart, and in other areas much finer and closer together, than in the other two panels; but that small areas containing either very fine cracks or none at all are present in all three of the panels. The significance of these observations is apparent:

Bearing in mind what has already been pointed out in the first paragraph of this paper—that cracks become individually wider and farther apart as the thickness of the coating layer increases, and narrower and closer together as it decreases—we can conclude from the pattern of cracks developed in the three panels that the coating thickness of the left two was on the whole fairly uniform while that of the right varied considerably. Furthermore, since the right panel, in spite of its wide variations in that respect, had the least average thickness of the three (namely, 0.042 in. as against the others 0.054 and 0.061 in.), it is clear that among its several relatively thick areas there must be a large number that are quite thin, considerably thinner than those on the other two panels. This could readily explain the numerous abrupt variations in the frequency pattern of the cracks in that panel and the numerous small areas in it showing fine, closely spaced cracks. On the other hand, the center panel, since it had a greater average thickness of coating than either of the other two (0.061 in., as against 0.054 and 0.042 in.), should be expected to show, as it does, somewhat wider and farther-spaced cracks than the others by reason solely of that greater thickness. This is borne out, in fact, by the sudden narrowing and closer spacing of the cracks near the corners of the center panel, where it is clear that the coating had thinned out.

All in all, therefore, such differences as do appear in the pattern of the cracks on the three panels can apparently be completely accounted for as due solely to the variations in coating thickness that were inadvertently introduced in the preparation of the panels. It seems self-evident that in all three of them, areas of about equal thickness have the same pattern of wide, far-spaced cracks, and areas of about equal thinness have the same pattern of fine, closely spaced cracks. The general design of the crack network, on the other hand, and the appearance and general contour of the asphalt at the lips of the individual cracks, seem to be virtually the same in all three. On the whole, it cannot be said that any substantial difference in the resistance of the three coatings to spontaneous cracking has been shown. In other words, and contrary to reasonable expectations based on past laboratory tests, neither does the heat-hardening of the asphalt in the center panel seem to have decreased its resistance to spontaneous cracking in actual roofing exposed outdoors, nor does the addi-

tion of filler to the asphalt in the right panel seem to have increased that resistance, to any perceptible degree.

Stated more concretely, the reduction of 4 or 5 points in penetration and the increase of 6 to 8 deg. in softening point, when effected either by heat-hardening or by the addition of filler, does not seem to have affected the crack resistance of the coating asphalt to a sufficient degree to be reflected clearly by any alteration in the basic cracking pattern of the asphalt involved. This particular thought has a bearing in our evaluation of the other panels exposed in 1938, in which no attempt was made to obtain parity in penetration and softening point between the unfilled and the corresponding filled asphalt.

Let us now examine the photographs of the other panels (Nos. 5 to 10, inclusive): As in the case of the No. 4 series previously discussed, we frequently see in the reproductions sharp changes in the spacing pattern of the cracks from one part of the panel to another, manifestly due to corresponding variations in the coating thickness that must have inadvertently been introduced when the specimens were constructed. Judging each panel as a whole, however, one cannot help concluding that the cracks in the filled coatings are in nearly every case inclined to be somewhat wider and more pronounced than in the unfilled.

This trend cannot well be attributed to the degree of hardening effected by the addition of the filler, since that is generally no greater than in the 1935 set, averaging a 3.6 point drop in penetration and a 10 F. increase in softening point, so a tendency to cracking due solely to that effect should be expected to be no more noticeable in the 1938 than in the 1935 series. As to the comparative thickness of the layers of unfilled and filled coatings, this point was determined in the case of panels Nos. 9 and 9(*a*), and Nos. 10 and 10(*a*), the difference in thickness as between the filled and unfilled coating layers in the two pairs referred to being negligible (0.041 as against 0.039 in. in the one pair, and 0.047 as against 0.049 in. in the other). In the case of panels Nos. 5 to 8, inclusive, this difference was unfortunately not determined at the time the specimens were prepared, because of the pressure of routine work, though inasmuch as all panels were constructed in the same way and the coatings were all smoothed out with the doctor blade adjusted to the same clearance, we should be justified in assuming, for the time being and until this assumption can be verified by actual measurement when the panels are finally removed from the roof deck, that the difference in average thickness as between the unfilled and filled coatings was negligible on those panels also.

Bearing these considerations in mind, we might at first be tempted to conclude that the unfilled coating had had the better of the filled in resistance to spontaneous cracking. Nevertheless, in view of the fact that the difference between the two groups in that respect was but slight, and that in all fairness at least some small allowance should be made for the slightly harder consistency of the filled coatings, and that, finally, there is as yet no definite proof that the thickness of at least some of the filled layers on the yet unmeasured panels was not greater than that of the unfilled, it would perhaps be safer to conclude that the cracking resistances of the filled and unfilled coatings were *approximately* on a par. There is no doubt, however, that the filled coatings in panels Nos. 5(*a*) to 10(*a*), inclusive, failed to show any *greater* resistance to spontaneous cracking than the unfilled, as had been anticipated at the start of the exposure test.

Weathering Behavior of Asphalts of Lower Softening Point

Though we have hitherto been discussing solely the fully air-blown asphalts, it will be recalled that we had exposed panels of straight vacuum-reduced and partly air-blown asphalts also. Owing to the greater flow and self-healing powers of these latter two groups of coatings as compared with the fully air-blown variety, checking and cracking did not develop in them as rapidly as it did in the other, and no clear trends could be observed during the first three years of their exposure. However, in the more recent inspection of the 7.5-yr. old panels, a few very interesting and significant trends did appear, as illustrated in unfilled panels Nos. 1, 2, and 3, and their filled counterparts, Nos. 1(*a*), 2(*a*), 2(*b*), and 3(*a*).

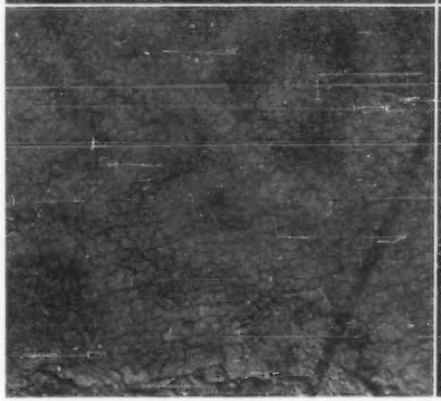
A glance at the illustrations will show that in every case the three unfilled layers had slid to some extent, that as a result of such sagging they had thinned out in small areas here and there, and where so thinned out the coating layer had finally weathered more or less completely away, exposing the felt. This is most clearly visible in panel No. 3, but similar though smaller patches of bare felt can just be made out in the photographs of panels Nos. 1 and 2, especially with the aid of a magnifying glass. On the other hand, the four corresponding filled asphalts, on panels Nos. 1(*a*), 2(*a*), 2(*b*), and 3(*a*), show not a trace of such weathering away of the asphalt. It seems clear, therefore, that while the two fillers used in that group were the same fillers C and D that had apparently not been able to effect an improvement in the crack resistance of the fully air-blown asphalts, they had been able substantially to benefit those of the lower softening point. The only logical explanation of this phenomenon seems to be that the main service the fillers performed was to stabilize the asphalt (that is, retard its movement) and prevent its flowing out so thin in places as to permit the destructive effects of weathering to penetrate through its entire depth at those points and thus destroy it. Where, however, asphalts of higher softening point were used that did not flow or sag, even when unfilled, this important service of the fillers would not be called into play, and the unfilled product would therefore in many cases behave about as satisfactorily in actual weathering as the filled.

It is true that when filler E was employed (which corresponds to Strieter's No. 16, finely ground Peach Bottom slate flour, which had been proved by his Weatherometer and aluminum panel exposure tests to rank among the three most efficient fillers, yielding place only to

Panel No. 7
Unfilled

Panel No. 8
Unfilled

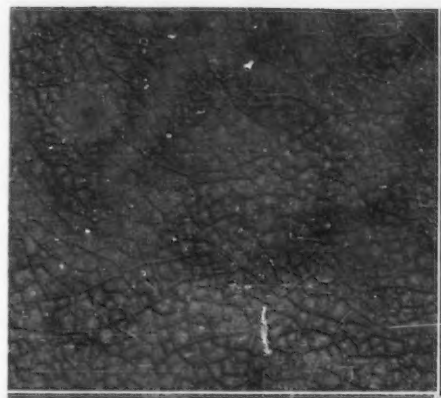
Filled
Panel No. 7(a)



Filled
Panel No. 8(a)

Panel	No. 7	No. 7(a)	No. 8	No. 8(a)
Asphalt				
Type	Grade G		Grade U	
Source	Fully air-blown Texas		Fully air-blown Texas	
Penetration at 77 F	21	18	23	20
Melting point, deg. Fahr.	207	216	205	217
Ductility, cm.	(2.5)	(1.5)	(2.5)	(1.5)
Specific gravity at 60 F.	1.078	1.342	1.037	1.329
Filler				
Type	...	D	...	D
Per cent by weight	...	35.0	...	38.1
Coating thickness, in.	...	...	...	...
Exposure, yr.	7.5	7.5	7.5	7.5

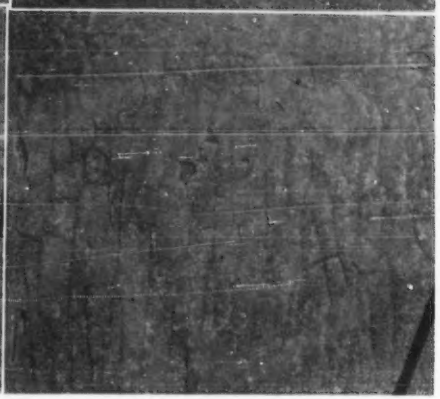
Panel No. 9
Unfilled



Panel No. 10
Unfilled

Filled
Panel No. 9(a)

Filled
Panel No. 10(a)



Panel	No. 9	No. 9(a)	No. 10	No. 10(a)
Asphalt				
Type	Grade G		Grade U	
Source	Fully air-blown, Texas-Venezuelan		Fully air-blown Texas-Venezuelan	
Penetration at 77 F.	23	18	23	19
Melting point, deg. Fahr.	216	225	218	228
Ductility, cm.	2.6	1.4	2.7	1.3
Specific gravity at 60 F.	1.06	1.35	1.030	1.360
Filler				
Type	...	E	...	E
Per cent by weight	...	(33.0)	...	(38.0)
Coating thickness, in.	0.041	0.039	0.047	0.049
Exposure, yr.	7.5	7.5	7.5	7.5

mica and talc), our panels showed a vast improvement during the first two years in the filled product, as practically no cracking took place in the latter; but between the second and third years the Texas-Venezuelan coatings in which that filler had been used (we quote again from our report of November 19, 1941):

"...began to fail rapidly, developing numerous deep, long cracks which made them rank worse (rather than better) than the mid-Continent filled coatings."

It is, therefore, barely possible (though such a hypothesis is advanced only tentatively) that even when the most efficient fillers are employed in coatings that naturally have no flow in service, and even when these fillers do retard the formation of cracks for a given period—say, three years or more by the aluminum-panel test as conducted by Strieter and two or more years when exposed on saturated felt in the open air—eventually the stresses built up in the filled coating do break loose, doing so perhaps the more rapidly in view of their preceding enforced confinement, and crack the asphalt layer open to possibly an even more marked extent than characterizes the unfilled layer. This raises the question whether Strieter's outdoor-exposed aluminum panels, in which the more efficient fillers were represented and which had consequently not as yet revealed any considerable degree of cracking at the end of the 3-yr. exposure period, were allowed to remain outdoors thereafter, and if so, whether any of them developed later on any evidence of rapid breakdown somewhat similar to that which eventually appeared in panels Nos. 9(*a*) and 10(*a*).

Conclusions

The author is frank to say that he has been nonplussed by his findings during the Madison exposure tests. He had expected to find a definitely greater resistance to cracking in the filled than in the unfilled, and instead he had found no clearly measurable difference. Actually, the difference, if any could be conceded to exist, appeared slightly to favor the unfilled, though the safer conclusion would undoubtedly be that the filled showed no superiority over the unfilled. The author realizes, however, that before even this more conservative conclusion can be generally accepted as sound, a great many more exposures in widely separated locations, and on panels prepared within narrower thickness and other tolerances than those exposed at Madison, should be started and kept under observation.

In the meantime, however, the mere possibility that some such trends do exist as here reported, raises the question whether a momentary halt should not be called to the growing insistence on the use of more and more filler in coatings for ready roofings, and while promptly initiating additional comprehensive investigations to gain further information in the matter, whether we should not place ourselves for the time being in a more "neutral" position on the question of filler by temporarily modifying the present requirement for filler in the three A.S.T.M. specifications for asphalt roofing, so as to make the use of filler optional rather than obligatory. That modification could be made by merely omitting the minimum from the present maximum-minimum requirement covering the per cent by weight of mineral matter in the coating, and inserting the clause "that may be" before the word "compounded" in the middle of the second paragraph, in Tentative Specifications for Asphalt Roofing Surfaced with Powdered Talc or Mica (D 224 – 44 T)[5], Tentative Specifications for Asphalt Shingles Surfaced with Coarse Mineral Granules (D 225 – 44 T)[6], and Tentative Specifications for Asphalt Roofing Surfaced with Coarse Mineral Granules (D 249 – 44 T).[7]

If, in due course, we establish that fillers, contrary to the findings here reported, do improve ready roofings under actual exposure conditions, we can always reinsert a suitable minimum for filler. On the other hand, if the author's findings should be corroborated by future investigations, the minimum requirement could be omitted permanently, so that the use of filler, while not forbidden, would be optional rather than obligatory.

Some time after this paper had been submitted to the Society for publication, and as if emphasizing the need there indicated for reconsidering the present provisions for filler in the A.S.T.M. specifications for asphalt roofings, a sample of 65-lb. smooth-surface roofing from an unknown manufacturer that was being currently promoted in the Colorado territory was received in the author's laboratory for test. On analysis, the coating was found to contain 48 per cent of a filler consisting wholly of plain sand, of the type frequently referred to in the trade as 50- or 60-mesh roofing sand. The filler had 7 per cent of 200-mesh and some 12 per cent of 100-mesh material; most of its balance was 60 and 50-mesh. The use of such a sand as filler in coating would no doubt be frowned upon by the large majority of roofing manufacturers, and yet it is significant that in spite of that, the sample of roofing in question complied with every single provision of the present specifications for Asphalt Roofing Surfaced with Powdered Talc or Mica (D 224 – 44 T). Clearly something should be done for the protection of those manufacturers who use the finer and better and more costly grades of filler in their coating, by inserting a clause in the specifications defining more closely what is meant by filler and what will be, and what will not be, acceptable as such.

[5] 1944 Book of A.S.T.M. Standards, Part II, p. 1427.
[6] *Ibid.*, p. 1430.
[7] *Ibid.*, p. 1422.

DISCUSSION

Mr. O. G. Strieter[1] (*presented in written form*).—The conclusion reached by Mr. Oliensis that the addition of fillers has not improved the resistance of the coating asphalts to cracking seems justified from the experimental evidence presented.

The discrepancies between the outdoor exposures and the laboratory tests are somewhat disconcerting. That the dolomite and limestone fillers, however, made a poor showing is not surprising. These are mainly corpuscular resolutions of the minerals and are not so very effective in stabilizing asphalts.

[1] Research Associate, Asphalt Roofing Industry Bureau, National Bureau of Standards, Washington, D. C.

Then, too, the lots selected may have been too fine, the bulk passing a No. 300 sieve. A coarser mixture would have been more desirable. The oyster shells, also carbonates, gave better results. According to the analysis, the filler was less fine and consisted mainly of jagged, needle-like particles.

The green slate, although not considered as good a filler as Peach Bottom slate, should have given better results. The filler, however, is considerably finer than that used by me and this may in part account for the poor showing.

Peach Bottom blue black slate can usually be counted on to produce a good stabilizing effect upon an asphalt. Unfortunately the particle size chosen is too fine, passing a No. 300 sieve. A particle distribution between No. 100 and No. 200 would have been desirable.

As to the question raised by Mr. Oliensis, the outdoor exposures in my tests were not continued beyond the 3-yr. period.

Mr. Oliensis has made a fine contribution, warning as he does, against the indiscriminate use of fillers. The experiments show that fillers do not always produce a real stabilizing effect. The need for further investigations on fillers is apparent, but the question of asphalts should not be forgotten as asphalts do not lend themselves equally well to stabilization.

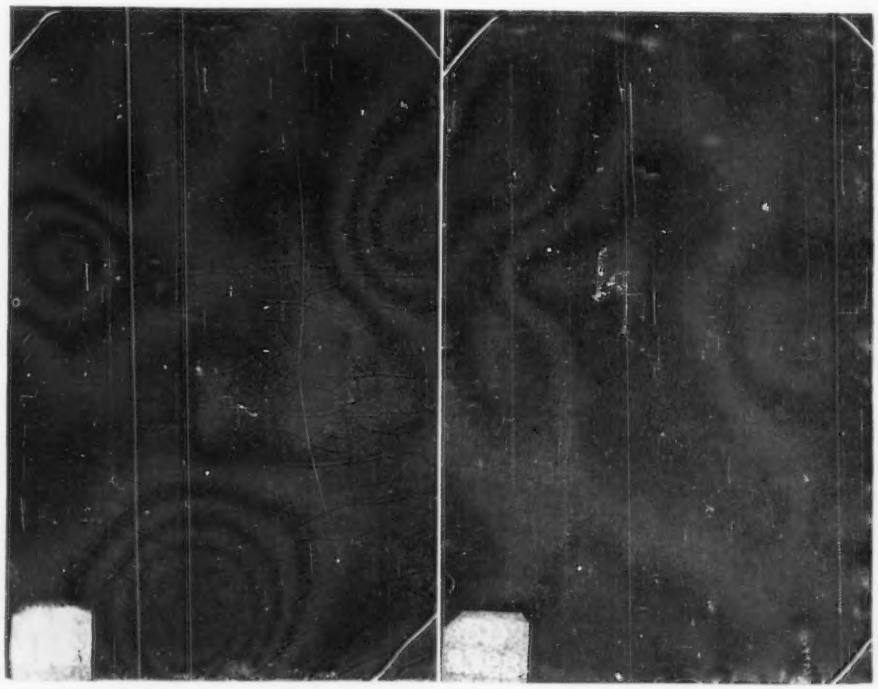
MR. MILTON R. BEASLEY[2] (*presented in written form.*)—In 1925 the writer built the first accelerated weathering machine for Bird & Son, Inc., for the purpose of developing an accelerated method for weathering asphalt roofings and their components, and after developing reasonable correlation between accelerated weathering and outdoor exposures, exposed duplicate samples of filled and unfilled asphalts, both in the accelerated weathering machine and on the test roof. These samples were exposed on both aluminum and saturated felt for the purpose of determining whether or not the variables introduced by saturated felt could be eliminated by using aluminum panels. Too much work on this matter has been since performed and reported on by others to warrant further discussion at this time on the wisdom of this procedure and the desirability of using aluminum when it is desired to study the weatherability of coating asphalts. It is sufficient to say, however, that in studying the weatherability of asphalt roofing the various components must be first studied separately, then in combination, and finally in the form of the completed roofing.

I should particularly like to comment on, first, the fact that in making exposures on saturated felt, Mr. Oliensis used 14 by 14-in. samples of No. 15 asphalt-saturated rag felt. No. 15 asphalt-saturated rag felt is not a satisfactory base for studying the effect of weathering of coating asphalts because it is made up of a light, 25-lb. felt and saturated to only 140 to 150 per cent of the dry felt weight, whereas roofings are normally made up on a 48-lb. felt and saturated to 175 to 200 per cent of the dry felt weight.

I have, through the courtesy of one of my industry friends, samples of three different asphalt coating combinations, both filled and unfilled and exposed to natural weather on saturated felt from 1937 until June 25, 1946. These are shown in Figs. 4 to 6.

Figure 4 was exposed April 8, 1937. The asphalt coating was made from 100 per cent talco crude asphalt and the same coating with the addition of 35 per cent blue black slate flour. The unfilled sample on aluminum showed surface cracks in 1 yr. and 4 months and failed in the spot test in 2 yr. and 4 months. This same material, on saturated felt, showed bad cracking in 1 yr. The filled sample showed cracking on aluminum in 6 yr. and failed in the spot test in 6 yr. and 4 months; and on saturated felt showed mild cracking in 6 yr. These samples on saturated felt have now been exposed 9 yr. and $2\frac{1}{2}$ months.

Figure 5 was exposed September 20, 1937. The coating was made from 20 per cent talco crude and 80 per cent Panuco crude, filled with 40 per cent blue black slate flour. The unfilled sample on aluminum showed first cracks in 2 yr. and spot test failure in 4 yr. First cracks in the coating, on felt, appeared in 1 yr. and heavy cracks in 1 yr. and 8 months. The filled sample on aluminum showed first cracks in 6 yr. and spot test failure in 6 yr. and 8 months. First cracks appeared, on saturated felt, after 5 yr. These

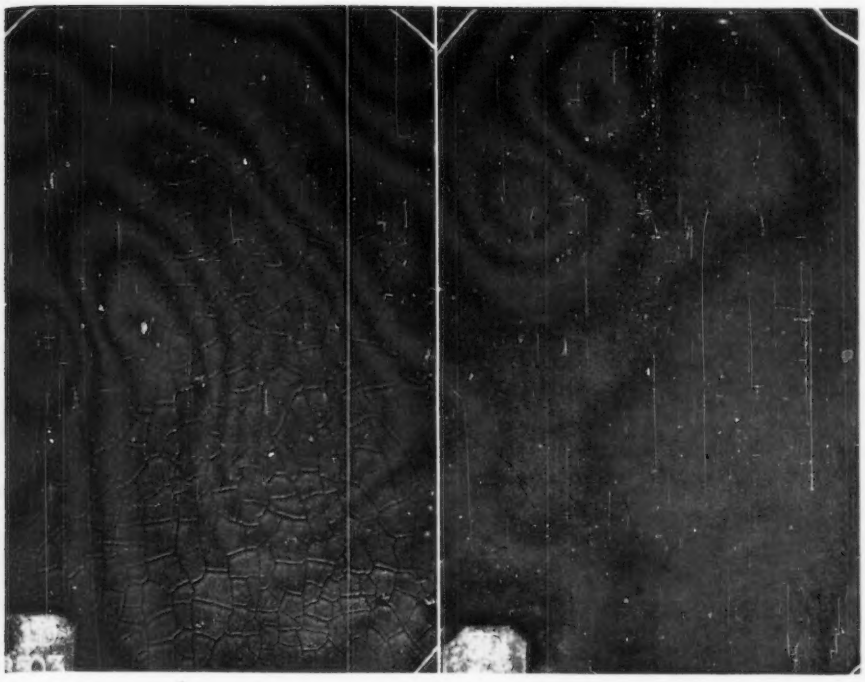


Blown to 210° F. softening point, unfilled. Applied to saturated felt.

Blown and filled with 35 per cent blue black slate dust. Softening point, 212 F. Applied to saturated felt.

Fig. 4.—Talco Crude, after 9 yr., 2.5 Months' Roof-Deck Exposure.

[2] Consulting Chemist, Norwood, Mass.



Blown to 217 F. softening point, unfilled. Applied to saturated felt.

Blown to 217 F. softening point and filled with 40 per cent blue black slate flour.

Fig. 5.—20 per cent Talco Crude, 80 per cent Panuco Crudes, after 8 yr., 10 Months' Roof-Deck Exposure.

samples have now been exposed for 8 yr. and 10 months.

Figure 6 was exposed September 20, 1937. The coating was made from 100 per cent talco crude asphalt and filled with 42 per cent oyster shell filler. The unfilled sample on aluminum showed first cracks in 1 yr. and spot test failure in 3 yr. and 8 months. The first cracks, on felt, appeared in 1 yr. The coating containing filler on aluminum showed first cracks in 7 yr. and 8 months and spot test failure in 8 yr. First cracks, on felt, appeared in 6 yr. and 8 months.

All of these samples had a coating thickness of 0.025 in.

Now it would appear that the results obtained by Mr. Oliensis may be misleading, due to the fact (see Table I) that thicknesses of coating varied from 0.035 to 0.061 in. and also that "during the war years only cursory inspections were made and it was not until this past fall, or after $10\frac{1}{2}$ yr. exposure on the first series and $7\frac{1}{2}$ yr. on the second series that these panels were really given a thorough inspection," with the result that due to variation in thickness of coating film, plus the lack of frequent inspections, the coating films all show cracking due to long exposure.

In closing, I should like to call attention to the fact that, in my mind, filler has an effect on asphalt physical properties of equal importance to the improvement in weathering, namely, it makes an asphalt shatter-proof at low temperatures. Roofing is applied in cold weather and, after application, is subject to mechanical damage, especially in cold weather due to ice and hail. Roofing without filler, when hit with a hammer during cold weather, loses its coating and surfacing due to the shattering of the coating asphalt, whereas roofing made with filled coating is not affected.

MR. R. H. CUBBERLEY[3] (*presented in written form*).—Mr. Oliensis has presented factual data of actual outdoor exposure results of assemblies composed of two of the three main components of prepared roofing. The evidence of these samples is incontrovertible in his particular field. However, we should like to present equally incontrovertible evidence in slightly different fields. No doubt similar data can be cited by other members and when such evidence is compiled we feel it is the function of Committee D-8 on Bituminous Waterproofing and Roofing Materials, to arrive at an intelligent interpretation. This *interpretation* is the crux of the discussion.

[3] The Flintkote Co., East Rutherford, N. J.

Blown to 216 F. softening point, unfilled. Applied to saturated felt.

Blown to 216 F. softening point and filled with 42 per cent oyster shell filler.

Fig. 6.—100 per cent Talco Crude, after 8 yr., 10 Months' Roof-Deck Exposure.

Being suspicious by training, we, too, were not content to rest our case on the comparison of coatings on metal alone. It was realized that the intent of such tests was to reduce test variables to a minimum and to improve the convenience of testing. However, our tests were paralleled in many instances by exposures on well-saturated shingle felt. This was even carried one step further to include a comparison of the final assembly, namely, the finished shingle.

In the accompanying Fig. 7, the spot test on aluminum shows an excellent correlation between the Bureau of Standards cycle of accelerated weathering and northern exposures where per cent filler is plotted against failure time in months. The New Orleans correlation is only fair, as might be expected. That just means the cycle must be modified to predict southern territory results more accurately. This correlation can be repeated many hundreds of times from our archives. Statistical analysis shows an average deviation from the mean of 10 to 15 per cent, although individual comparisons may vary as much as 100 per cent. These figures refer to the ratio of accelerated to outdoor exposure spot test failures.

Taking the next step, shown in the accompanying Fig. 8, failure by severe cracking of the coating under visual inspection on the saturated felt base agrees surprisingly well with accelerated and outdoor tests on metal, in so far as northern climates are concerned. In the south the relationship still exists, but the case again is not quite so clear cut.

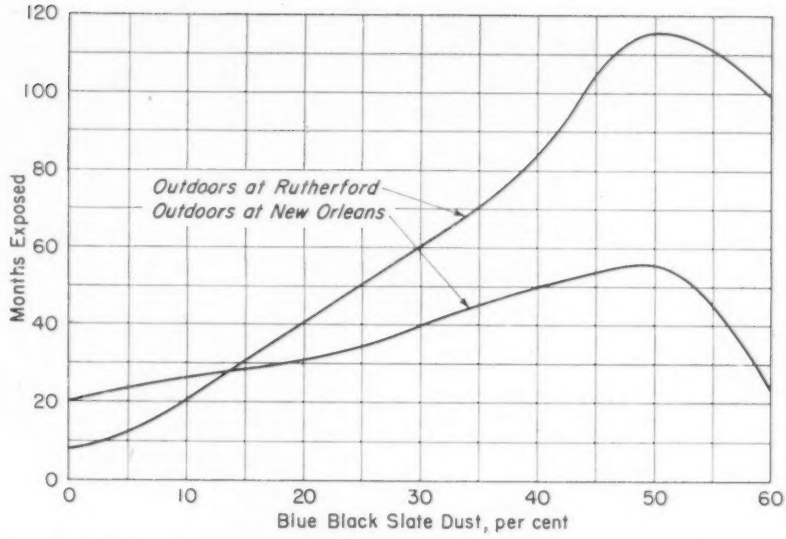


Fig. 8.—Weathering of La Rosa Asphalt with Various Amounts of Blue Black Slate Dust. (Severe cracking on saturated felt.)

It will be noted from these exhibits that (1) the maximum benefits are secured by considerably higher filler percentages than any reported by Mr. Oliensis, (2) initial failure of the best combinations do not occur before eight or nine years of outdoor exposure at Rutherford.

As previously indicated, this is still not the whole story. We must remember that the over-all life of this product is dependent on three component qualities:

(*a*) Saturated felt of permanent water resistance,

(*b*) Coating asphalt of exceptional durability, and

(*c*) Effective granule protection for the asphalt coating.

The final proof of the staying power of this team is just beginning to evidence itself under the severe climatic conditions of our New Orleans exposure farm. Naturally, such data accumulate very slowly. An early series of commercial shingles, made with and without filler in the coating of otherwise identical samples, shows approximately a 3-yr. improvement in the life expectancy of the group with the filler as compared with the controls. This is based on a mathematical weighted observation of defects and, it should be mentioned, includes percentages of the order of magnitude investigated by Mr. Oliensis. Samples of still higher filler percentages followed at a considerably later date, after some inkling of the possibilities for improvement were comprehended. These samples are still running, of course.

In commenting on the data and interpretation given by Mr. Oliensis, it seems a little strange that the felt was so carefully protected from moisture by sealing with plastic cement, a condition which is entirely foreign to normal exposure of prepared roofing. We believe, also, that Mr. Strieter's method of adjusted final melt point conforms more closely to commercial practice. Further, we should like clarification

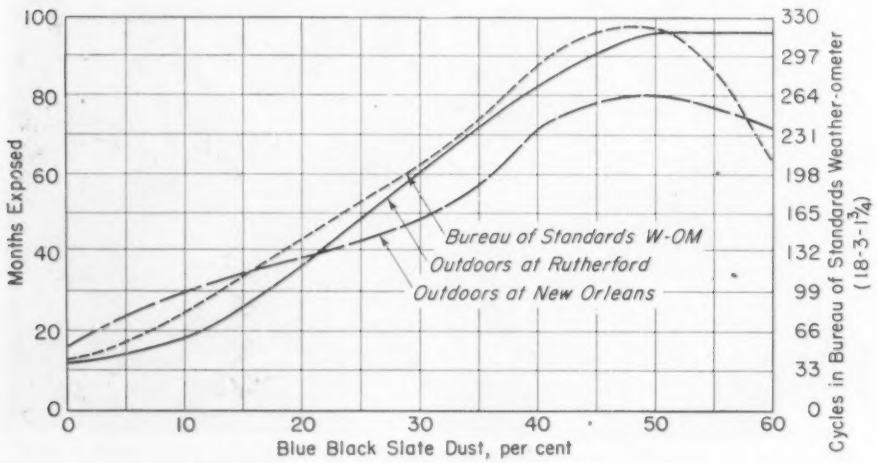

Months Exposed
Bureau of Standards W-OM
Outdoors at Rutherford
Outdoors at New Orleans
Cycles in Bureau of Standards Weather-ometer (18-3-1¾)
Blue Black Slate Dust, per cent

Fig. 7.—Weathering of La Rosa Asphalt with Various Amounts of Blue Black Slate Dust. (Spot test failure in aluminum.)

regarding the angle of exposure of the specimens, as a dead level roof is certainly not normal for the industry product. The size of our samples on saturated felt were 4 by 6 in., but it should be remembered that millions of squares have been produced with tabs only slightly larger.

Next, we should like to ask Mr. Oliensis whether he has considered the possibility that the durability of his coating over a short term may be the most significant observation, inasmuch as good granule protection will add many years of life to the poorer unfilled controls. If the granules add the same, or more, years of life to the filled coatings, the over-all life expectancy of the final assembly must by the same token be appreciably advanced. If such reasoning is correct, it follows that comparisons of filled and unfilled unprotected coating, long after both have passed the severe cracking stage, would be largely academic.

In conclusion, based on the data available to us, we do not feel that the responsibility of the Society to the consumer could be conscientiously discharged by any relaxation in the tentative specifications calling for the use of mineral filler in asphalt prepared roofing coating.

CHAIRMAN J. S. MILLER[4] (*presented in written form.*)—This paper is as informative as the author's papers usually are, since he always gives complete details of the work and exhibits extreme care in reporting the data upon which his conclusions are based. I know these traits from our many years as associates in asphalt technology.

I should like to point out that in the case of the so-called "Fully airblown" coatings, they appear to me to be rather soft in that they have penetrations of from 21 to 23 and softening points from 202 to 218 F., while the usual minimum for unfilled coatings is of the order of 18 penetration and 220 F. softening point. Would the use of a harder coating before addition of filler change the final picture?

If we analyze the surface configurations so general in his illustrations, I would conclude they are of the alligator type in which cracks will develop ultimately, but in which it is not usual to have those cracks open all the way to the panel early in their life, as when vertical cracks occur without any alligatoring preceding the cracking.

Alligatoring is a phenomenon noted in the varnish and paint industry. A hard second or third coat brushed on over softer undercoats is one cause. In asphalt we have surface hardening occurring, and if the under part of the coating is too soft, the movement of the soft layer is sufficient to cause cracking in the thin hardened surface which exposes the softer coating underneath. Such surface film cracks always show bright shiny coating in the cracks. The process is repeated in these thinned out areas and ultimately the remaining film in the thin areas has no soft coating beneath it and it either remains intact for some time or actually cracks through to the base material at which time destructive failure proceeds rapidly.

Until definite correlation between accelerated weathering tests and long-time exposure to actual weather is achieved, I have never accepted its results as truly indicative of what can be expected of roofing. However, I do believe the results aid materially in evaluating the efficiency of fillers and also the relative weathering properties of different asphalts.

One must have standard conditions in such accelerated tests—rigidity of exposure plate, definite thickness of films, etc.' One of the reasons why results of such panels cannot predict what will happen when the same coating is applied to a sheet of felt is brought out by the author—flexibility of roofing and its consequent flexing under stresses of wind and movement of roof deck beneath the roofing. Another, and I believe one of the chief causes, is lack of uniform thickness of coating over the felt base. Felts of supposedly the same weight and thickness vary greatly in thickness. Therefore, on high spots we have thin and on low spots thick coatings, which is conducive to more rapid deterioration in the thin spots.

However, this paper brings forth a vital need in asphalt roofing design, a means of more rapid prediction as to what constitutes the best coating and, secondary, how to obtain roofing with a uniform thickness of coating over its entire area whether one believes in a thin or a thick coating, with or without a mineral filler.

I cannot understand how there can be "growing insistence on the use of more and more filler in coatings" since any reputable manufacturer would be the first to determine the limitation as to what amount of filler can be used and still maintain the bending properties required and by comparison in weatherometer tests determine the limits as to filler content.

The A.S.T.M. specifications for asphalt roofings adopted by the Society upon recommendation of Committee D-8 were developed by and with the aid of many roofing manufacturers' representatives with all the data available to such a group and were based entirely upon the best judgment of that group of technical men being a representative cross-section of the technologists and production men of the asphalt roofing industry.

The very fact that no specification for the type or characteristics of fillers was introduced indicates the group did not feel the last word had been said with regard to the filler question, other than that filler seemed to provide an improvement in roofing coatings.

MR. G. L. OLIENSIS (*author's closure*).—The evidence cited by Messrs. Beasley and Cubberley would seem on the face of it flatly to contradict my own exposure tests, and yet the apparent contradictions may be susceptible of a fairly simple explanation, as follows:

Cracking Stresses Exerted by Wind and Vibration:

In the forepart of my paper I had emphasized the destructive effects of these two agents on bituminous roofing. It follows that in order to avoid either too extreme or too mild reactions from that cause in one's exposure panels, it is just as important that the latter be shielded from any abnormally severe wind or vibration stresses, as it is that they *should* be subjected to the *normal* stresses of that nature. To

[4] Consultant on Asphalt Technology, Rahway, N. J.

attain that normality of stress action, it will be recalled that the large roofing panels discussed in my paper were cemented permanently to the old sheet roofing on the Madison warehouse roofdeck, thus assuring for them exactly the same degree of movement as the latter had and therefore about the same degree of movement that the average built-up or smooth or slate-roll roof would have. Mr. Beasley, however, did not take that precaution. He used, in the first place, extremely small panels—all edges as it were—and then, as I understand, he placed these very small samples at a 45-deg. angle on an open rack, where they were bound to be subjected not only to direct weathering from both face and back, but to a wholly abnormal type of wind stress to which no roofing is ever subjected. Just how Mr. Cubberley exposed his specimens is not clear, but unless he, too, took special precautions as had been done at Madison to simulate natural exposure and natural movement, his flexible felt panels could no more be depended on to forecast actual weathering effects than could his rigid aluminum panels, which are capable of no vibration at all.

It is admitted that filled coatings have a different hardness, a different "body," a different susceptibility to temperature changes, a different resistance to certain types of impact, than the unfilled. It is admitted too—and I have myself pointed it out in my paper—that in many ways these differences definitely favor the filled coatings. It is known, for instance, that if an unfilled coating applied on saturated felt is slammed smartly by hand against the floor or the laboratory table top, it will shatter more than the filled coating. It is therefore quite possible that if an unfilled coating on saturated felt is exposed to the weather in such a manner that it is stressed or vibrated abnormally, or otherwise abused, such coating may develop cracks more quickly than the filled may under the same abnormal conditions. But the important question is: Do these differences in favor of the filled coatings under abnormal exposures actually play a decisive rôle in the life expectancy of roofings *as they are actually applied and as they actually weather?* We know how grossly others have been misled by exposure tests that were at first considered a substantially close approach to actual conditions, but that time proved to be just different enough from them as to yield indications diametrically opposite to those developed in actual service. Precisely this point was strikingly illustrated by Mr. Kettering's recent findings (cited in the forepart of my paper) that moisture in the form of a *spray* caused no corrosion on his paint panels, yet moisture in the form of *dew* did cause decided corrosion. No one, without having actually witnessed it, could possibly have anticipated such a vast difference in results from such an apparently trivial and inconsequential difference in test conditions.

It follows that in view of the many special precautions that were taken to subject the Madison panels to as nearly actual exposure conditions as possible, whereas the necessity for such precautions were apparently not realized when the Beasley and the Cubberley panels were exposed, the results of the Madison tests should be accepted as more accurately forecasting actual weathering effects than the others, at least until further tests under still more rigidly "natural" conditions have been made.

Blue Black Filler versus Other Fillers:

There is, however, another consideration bearing on the admissibility of the data cited by Messrs. Beasley and Cubberley, and that is, the absence therefrom of a number of links that should logically have had a place in their chain of evidence but that have for some reason been omitted. In my paper, I described the character and behavior in filled coatings of five different fillers—all that I had actually used in my exposure tests. In Strieter's work, 19 different fillers were tested and the characteristics and behavior of all of them, without exception, were discussed. In both his investigations and mine, one of the interesting developments brought out was the greater toughening and crack-resisting effects of blue-black slate flour. Yet all the panels presented as evidence by both Messrs. Beasley and Cubberley are based (except for one set containing oyster-shell filler) on this "choice" type of slate flour. One cannot help regretting that, instead of citing coatings containing this relatively rare type of slate flour, and in the one case the equally little-used oyster-shell filler, each of which two represents but a couple of per cent of the total tonnage of coating fillers used in the American roofing industry, they did not include some of the other more common fillers—such as limestone dust and dolomite, for instance, which together represent about 80 or 90 per cent of the total filler tonnage.

Mr. Beasley did, in fact tell me frankly, in conversations and correspondence subsequent to last summer's A.S.T.M. meeting, that he had tested numerous other fillers, and that he had found that certain commonly used fillers, to use his own words, "only slightly improved the coating," while some of the less commonly used ones "actually destroy the life of an asphalt." Does it not seem, in view of the foregoing, that this information should have been included in the discussions by Messrs. Beasley and Cubberley at the summer meeting; or, if they did not at the time feel at liberty to divulge their tests on these other fillers, that they should at least be willing that consideration of the partial data they did present on the better filler, should be postponed till such later time as they do feel at liberty to release the rest of their data?

However, it is not really necessary that the issue be drawn as sharply as here indicated. It is not as if my report had aimed to discredit the use of filler in asphalt. On the contrary, my paper has cited evidence that fillers definitely benefit the low-melting-point asphalt of the self-healing and semi-self-healing type. Even with respect to the higher-melting-point asphalts of no self-healing properties such as used in ready roofings, I have claimed, not that unfilled coating is necessarily better than filled, but that (1) *under actual exposure conditions*, unfilled coatings have made fully as good a showing as the filled, and should therefore not be excluded summarily from the A.S.-

T.M. specifications as they are at present, and (2) that the present provisions of the A.S.T.M. specifications for filler need tightening so as to exclude plain roofing sand and other types of filler generally recognized as unsuitable, and prescribe means for determining the uniformity of the distribution of the fillers in the coating, and their freedom from moisture, dirt or other undesirable constituents.

I am still hoping that both these suggestions will be given due consideration; and at the coming meetings of Subcommittee III on Roofings of A.S.T.M. Committee D-8 on Bituminous Waterproofing and Roofing Materials, I shall be glad to submit some very simple changes in the wording of the present specifications, and some simple supplementary tests, that I believe will make it possible to attain both these objectives.

I do not wish to close without answering briefly some of the questions that have been raised in the several discussions of my paper.

Mr. Miller asks whether I had not possibly mistaken alligatoring in the Madison panels for genuine cracking. His question was probably prompted by the rather deceptive shadow lines on the views. It is true that the low-melting-point, partially self-healing coatings on the six panels 1 to 3(*a*) inclusive did alligator, the cracks apparently never extending down to the felt. But the cracks in all the other panels were genuine ones—with sharp parallel vertical edges extending apparently straight down to the felt. Even the hair-checks in these other panels, when examined under the magnifying glass, were of the same type, though on a much finer scale, and these hair-cracks too seemed, as nearly as that could be judged, to extend straight down to the felt.

Mr. Beasley questions my use of 30-lb. felt rather than the 48 lb. grade that he has employed, and my selection of an average coating thickness of 0.043 in. rather than the 0.025 in. which he used. It should not be overlooked that enormous quantities of felt other than 48 lb. are being employed in built-up roofing, smooth and slate-surfaced roll roofing and even in shingles; and that the coating thickness applied on these various roofings range from a figure very much lower than his 0.025 in. to one very much higher than my 0.043 in. Why, then, assume that only 48-lb. felt and only a 0.025-in. thickness of coating layer will give the right answers?

Mr. Beasley also feels that my observations may be misleading because—quoting his quotations from my paper—"during the war years only cursory inspections were made, and it was not till this past fall . . . that these panels were really given a thorough inspection;" and since by that time all the panels had cracked, no true evaluation of the different coatings and fillers was really possible. In his quotation, Mr. Beasley inadvertently omitted two rather important words. What I had actually stated was (italicizing the two omissions) as follows: "During the *subsequent* war years only cursory inspections were made. . . It was not until this past fall that they were all given *another* really thorough inspection and again photographed." Mr. Beasley overlooks that during the first two or three critical years of the panels' life, when the cracks were actually developing over most of them, I inspected and measured and took copious notes of the appearance and behavior of the panels both summer and winter, and that therefore the inspection made after the war was not the sole, but only the last, of a long series of thorough inspections.

Again, Mr. Beasley mentions that filled coatings show an improved resistance over unfilled to shattering in the cold. I pointed out exactly the same fact in my paper: They do show an improved resistance to shattering—if determined by arbitrary laboratory test. Yet I have actually tried nailing shingles on an actual roof deck at temperatures as low as 32 F., and have purposely pounded their slate surfaces with the hammer while doing so, using both shingles made with unfilled and shingles made with filled coatings, and I have myself been surprised at how very little the big difference obtained by laboratory test was reflected in the actual handling, nailing, and hammering operations on the roof. This illustrates how fallacious it frequently is to try to forecast performance in actual service from performance data obtained from arbitrary laboratory tests.

Mr. Cubberley points out that if the coating on the Madison panels had been protected with granules they would have resisted cracking much longer. This is perfectly true, but in the first place, the probability that the granules could not have been applied very uniformly on the laboratory-made test panels would have introduced one more factor, the variations in which would have tended to obscure the variations in the behavior of the coating proper, which was the main object of our study; and in the second place, there are thousands of squares of built-up roofing and of smooth-surface roofing that are not protected by granules. Why lull ourselves into a false sense of security by running tests on granule-protected coatings only, when so much roofing is in service that is not so protected?

Another question of Mr. Cubberley's is in reference to the slope of my roof deck. It is about $\frac{3}{4}$ in. to the foot—not very steep, but well within the limits considered proper for sheet roofing.

Finally, Mr. Cubberly questions why I cemented my panels to an old sheet roofing and waterproofed their edges with plastic cement. As explained before, the purpose of the cementing operation was to insure that the panels would become an integral part, as it were, of the old roof and partake of all its natural movements and strains. And the edges were carefully waterproofed for the very simple but important reason that, since the panels were flush with the old roof, rain water would otherwise soak into and waterlog the felt, and eventually would disintegrate it, cause the coating to blister excessively, and in short prematurely ruin my panels before I was half through with their study. So I decided that to insure their normal behavior, these panels must be protected against the entry of surface water just as adequately as a regular built-up roof, or a smooth-surface or a slate-surface roll roof, is so protected, and that protection was effected by carefully

pointing up all the exposed edges of the panels with plastic cement.

In this respect it will be noted that I tried to reproduce natural exposure conditions as closely as possible. And it is precisely because in this detail as in every other, every possible precaution was taken to match actual service conditions, that I feel that the panels exposed at Madison are much more likely to forecast accurately the behavior of filled and unfilled coatings in actual exposure, than the other panels here discussed on which those special precautions were not observed—quite aside from the fact that in the latter the commoner fillers used in the roofing industry were not represented.

Proposed Method of Test for the Siliceous Grit Content of Paper and Paper Products

THE accompanying method was developed in A.S.T.M. Committee D-6 on Paper and Paper Products, specifically in its Subcommittee I on Paper Testing Methods. The group feels that there is need for a standardized method for determining the siliceous grit content of paper, and while the method as shown is satisfactory for certain types of paper there is not sufficient information to judge its suitability for all types. Through the publicity obtained by publication, the committee is hopeful that constructive criticism will result, particularly from organizations which are not represented in the Committee D-6 membership and who may have a broad and comprehensive experience with this particular problem. Following study of comments received, the committee hopes to refer the proposed method to the Society for publication as tentative.

Proposed Method of Test for the Siliceous Grit Contents of Paper and Paper Products[1]

This is a proposed method and is published as information only. Comments are solicited and should be addressed to the American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa.

Scope

1. This method of test covers the procedure for determining the siliceous grit content of paper and paper products that are used for purposes requiring punching and shearing operations. It is intended to be a measure of the abrasive properties, which may cause undesirably rapid dulling of punches and dies or of shear knives.

Apparatus

2. The apparatus shall consist of the following:

(*a*) *Beaker.*—A 1-liter pyrex beaker.

(*b*) *Filter Paper.*—No. 41 Whatman filter paper or equivalent.

(*c*) *Filtering Funnel.*—A fluted pyrex glass, Bunsen filtering funnel 65 mm. in diameter and having a 60-deg. angle.

(*d*) *Filter Cone.*—A platinum or paper filter cone.

(*e*) *Centrifuge Tube.*—Goetz phosphorus tube, glass (similar to Eimer and Amend Catalog No. 5-624), which is pear-shaped with a ground-glass stopper and has the stem graduated at the 25-, 50-, and 100-ml. marks and graduated from 0.0 to 0.2 ml. in 0.01-ml. divisions.

(*f*) *Porcelain Crucible.*—A Coors high-form porcelain crucible, having a capacity of 10 ml., diameter 30 mm. in at the top and 25 mm. in height.

(*g*) *Bunsen Burner.*

(*h*) *Desiccator.*—A desiccator containing anhydrous calcium chloride.

Reagents

3. (*a*) *Nitric Acid (fuming).*
(*b*) *Sulfuric Acid (sp. gr. 1.84).*
(*c*) *Distilled Water.*

[1] This proposed method is under the jurisdiction of the A.S.T.M. Committee D-6 on Paper and Paper Products. Published as information, January, 1947.

Procedure

4. (*a*) Weigh out (Note 1) about 25 g. of the air-dry paper to the nearest 0.01 g. and place in a 1-liter beaker.

NOTE 1.—If the paper contains a soluble impregnant such as oil or paraffin, it should be extracted before weighing with a suitable solvent in accordance with the Standard Method of Test for Paraffin Content of Waxed Paper (A.S.T.M. Designation: D 590).[2]

(*b*) Add 100 ml. of fuming HNO_3 and warm on the hot plate until the paper becomes a thin paste; then boil gently until a low-viscosity solution results. Evaporate the solution to a volume of 30 to 40 ml., cool, add 20 ml. of H_2SO_4 (sp. gr. 1.84), and heat until white fumes of SO_3 are evolved (Note 2). Clarify the solution by cautiously adding small volumes of fuming HNO_3, allowing the drops to run down the inside wall of the beaker, and reheat until SO_3 fumes are evolved. Repeat this clearing operation as often as is necessary to produce a clear solution which is a light straw color. When clear, give the solution a final fuming to remove the HNO_3.

NOTE 2: *Caution.*—The digestion should be conducted under a hood. Because of the corrosive characteristics of the acids specified, they should be handled with the utmost care.

(*c*) Cool the solution to room temperature and dilute to 400 ml. with distilled water. Boil gently for several minutes, filter while hot through a No. 41 Whatman paper or equivalent, and wash the residue with distilled water.

(*d*) Transfer the residue from the filter paper to a 100-ml. Goetz centrifuge tube, using distilled water for this purpose. Dilute the suspension to the 100-ml. mark with distilled water and, with the stopper in place, shake it vigorously by hand for about 1 min. Allow the suspension to settle partially under the force of gravity for exactly 10 min. at room temperature (22 to 28 C.). At the end of this settling period, siphon off and discard the supernatant suspension, being careful not to disturb the large particles which have settled in the stem of the tube. Again dilute to 100 ml. and repeat the shaking, settling, and siphoning operations three more times.

(*e*) After the fourth siphoning, record the volume of the particles collected in the stem of the tube and then add about 50 ml. of distilled water. Shake the mixture thoroughly, and quantitatively collect the particles on a No. 41 Whatman filter paper or equivalent. Place the filter paper containing the particles in an ignited and weighed porcelain crucible. Dry the paper, and ignite over a Bunsen burner until all the carbon has been burned off. Allow the crucible to cool in a desiccator and weigh.

(*f*) Calculate the percentage of grit, based on the air-dry weight of the sample.

[2] 1946 Book of A.S.T.M. Standards, Part III-B.

Report

5. The report shall including the following:

(*1*) The volume of grit determined in accordance with Section 4(*e*), and

(*2*) The percentage of grit, calculated on the basis of the weight of the paper. For purposes of acceptance and rejection, the results shall be reported to the nearest 0.01 per cent; for other purposes, such as tests applicable to research, the results shall be reported to the nearest 0.001 per cent.

Precision

6. The precision of the method (numerical value of the standard deviation of individual determinations of the percentage of grit content made on a series of 25-g. test specimens having highly uniform grit content) is approximately 0.002.

Correlating Laboratory Accelerated Tests and Outdoor Tests by Means of Instrument Testing for Change in the Physical Properties of Paints*

By Dave M. Williams[1]

THE information presented here is the result of a cooperative simultaneous exposure of paint test panels outdoors at Miami, Fla., and Cleveland, Ohio, along with indoor exposures at five laboratories in the Cleveland area. Primarily, it summarizes a paper[2] presented before a district meeting of the Federation of the Paint and Varnish Production Clubs, with additional information of direct interest to A.S.T.M. readers. The project has had the encouragement of the joint committee on Standards and Methods of Test of A.S.T.M. and the Federation.

CLEVELAND CLUB COOPERATIVE EXPOSURE[3]

The purpose of the Cleveland Club cooperative exposure was to gather data on the relationship between test-fence weathering and the results obtained in laboratory light and water exposure machines as normally operated, using Miami, Fla., land-rack exposure as the accelerated weathering effects to be duplicated. The list of properties considered when materials were selected for the panel test was extended beyond the usual chalking, checking, loss of gloss, and color. Additional properties were distensibility, adhesion, hardness, and rusting, with special emphasis on measuring the change in physical properties during exposure. In view of the great number of variables encountered in this type of project, the committee was particularly anxious to have the effect of each of the eight different exposures measured mechanically.

PROBLEMS INVOLVED IN MEASURING PHYSICAL PROPERTIES OF PAINT

Four major problems in measuring the physical properties of a paint film, and the methods used to overcome these problems are as follows:

Paint Film Top Drying:

How can you machine-test paint films which top dry to produce a condition far from isotropic in films applied to steel panels?

Provision for lack of an isotropic test specimen was made in the Cleveland Club exposure through the procedure of repeating the group of three tests—scrape hardness, lateral stress adhesion, and distensibility or elongation—during the drying out of the films and into the phase when the top drying condition had been met throughout the film. This was accomplished by testing initially and at outdoor exposure intervals of 10 days, 1, 2, and 4 months. These tests were applied on a progressive section of the 6 by 12-in. exposure panel by returning to the central air-conditioning room 3 by 6-in. sections at each interval. The same procedure was followed for machine exposures, but only a 2 by 3-in. panel was returned for testing at each test period. The results of three separate tests at each interval provide the safety factor of trends to avoid misinterpretation of any one type of test information.

Paint films, it can be shown, obtain a satisfactory isotropic condition with prolonged weather-like aging. The elongation curves of several typical alkyd materials show that early lack of uniformity is overcome by weathering; after 4 months of outdoor aging or 3 weeks of machine aging, the elongation of all four materials is almost identical, regardless of the initial reading (see Fig. 1).

The end point in the elongation tests is taken as the failure occurring when the surface of the metal panel is exposed to water. This end point insures that the drop from high readings to low readings is a true picture of the changes in the bottom of the film.

Adhesion:

What has been done about the influence of adhesion on hardness and elongation results?

Film bonding, or adhesion, is an important factor in elongation testing. The shortcoming of many distensibility tests arises from the fact that poor adhesion dissipates the elongating stress over a wide area, while good adhesion concentrates the stress, causing a series of readings which apparently indicated an improvement from low elongation to higher elongation when the cause was really not better elongation but worse adhesion. Such an example is shown in Fig. 2, panel 7.

A testing machine was available to the Cleveland Club which would reveal a change in the bonding of a film to the steel panel, so that when an adhesion failure occurred, the hardness test end point would not be confused by chipping due to poor adhesion. The machine and method, which were demonstrated to all members of the committee at a meeting held for the purpose, have been reviewed previously (3).[4] The machine and essential features are shown in Figs. 3, 4, and 5.

The method of test applies a standard stress to a progressively narrower cross-section of paint until the small adhering area cannot withstand the lateral stress applied against the side of the film by the pencil-like point as it cuts down into the subsurface. The higher the bond under otherwise constant conditions, the smaller will be the space in mils between the 2-in. long parallel grooves when the paint film is

NOTE—DISCUSSION OF THIS PAPER IS INVITED, either for publication or for the attention of the author. Address all communications to A.S.T.M. Headquarters, 1916 Race St., Philadelphia 3, Pa.

* Presented at a technical session sponsored by Committee D-1 on Paint, Varnish, Lacquer, and Related Products at Buffalo, N. Y., June 26, 1946, during the Forty-Ninth Annual meeting of the Society.

[1] Manager, Evaluation Dept., The Arco Co., Cleveland, Ohio.

[2] "Weathering Machine Correlation in the Cleveland Club Area," *American Paint Journal*, Vol. 30, No. 6A, 1945, pp. 20-28 or *Official Digest*, Vol. 250, Nov., 1945, p. 254.

[3] Members of the Cleveland Club Committee 20-28 are: Fred Oberlin, Ferro Enamel; S. L. Lorig, Ferbert-Schorndorfer Co.; Morrie Levine, Forbes Varnish; Eugene Wieth, and Samuel L. Huey, The Sherwin-Williams Co.; T. A. Neuhaus, The Glidden Co.; and D. M. Williams (chairman), The Arco Co.

[4] The boldface numbers in parentheses refer to the references appended to this paper.

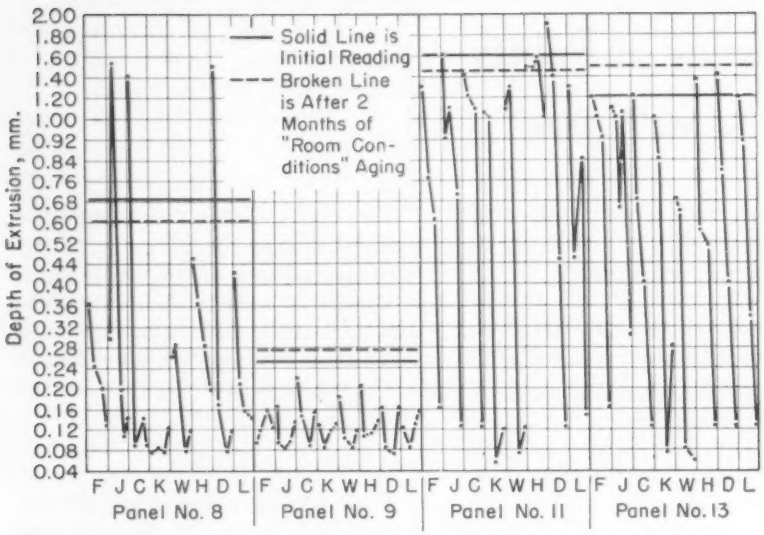


Fig. 1.—Elongation at Intervals of Exposure Outdoors and in Exposure Machines on Four Typical Alkyd Materials Showing the Uniformity of Readings after Weather-Like Aging.

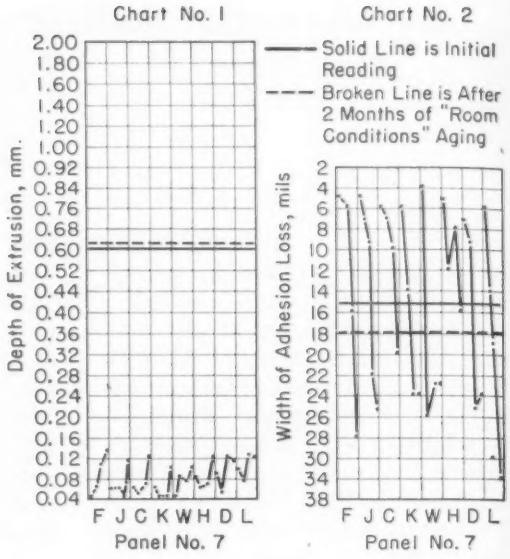


Fig. 2.—Elongation Chart 1 and Adhesion Chart 2 Indicate the Improved Elongation Reading from 0.04 to over 0.12 mm. Is Caused by the Severe Loss in Adhesion.

NOTE.—Each panel is completely graphed in one square. Exposure interval dots are connected by line. See legend for intervals. Solid horizontal line is initial elongation test reading.

Legend:

F—Florida: 10 days, 1 month, 2 months, 4 months.
J—Arco X-1A: 30, 50, 100, 154, and 210 hr.
C—Ferbert Schorndorfer X-1: 54, 126, 198, and 300 hr.
K—Glidden X-1A: angled rack. Intervals like *C*.
W—Arco X-1: intervals like *C*.
H—Ferro Enamel, single arc Atlas BWMC, intervals like *C*.
D—Sherwin-Williams X-1, intervals like *C*.
L—Olmsted Falls: 45-deg. South Fence, intervals like *F*.

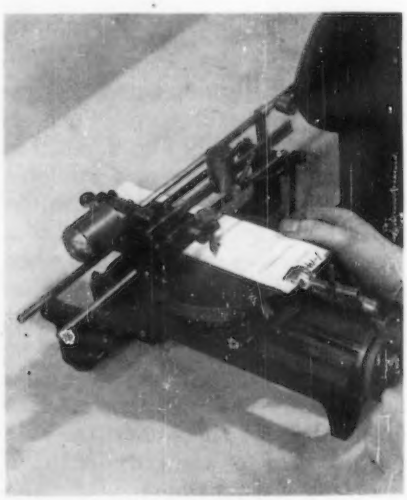


Fig. 3.—A General View of the Microknife* for Testing Adhesion.**

* Patents Applied for. ** Adhesion Method—Patents Applied for.

displaced. One half the area must be displaced to be considered for a reading.

Hardness and Elongation:

What has been done about the influence of softness and distensibility on the adhesion measuring method?

The influence of hardness and distensibility on the adhesion measuring method is appreciable, so that in making each adhesion test, the scrape hardness and elongation were tested at the same time on the same swatch. Hardness is measured beyond the "hard-to-the-nail" stage by use of the diamond-point tool shown in Fig. 4, loaded by means of a slide and beam to cause two strokes of the diamond point to penetrate the film to bare metal as observed through a 100× microscope.

Fig. 4.—Photomicrograph of Diamond Point Tool for Microknife, Indicated by Arrow (× 40 (approx.)).

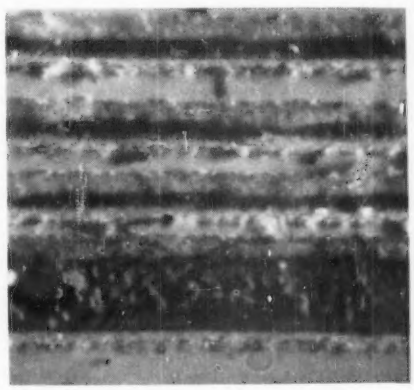


Fig. 5.—Photomicrograph Plan View of Paint Film Showing Application of Adhesion Test (× 40 (approx.)).

The panels were tested by applying a group of scrape tests, each 50 g. heavier than the preceding one. When the metal was revealed over half the distance of the 2-in. scraped area, a test reading was made.

The distensibility was measured in all cases by the use of the Elongauge, a device the details of which have not been previously published, but whose operation can be easily understood from the knowledge of the Erichsen sheet metal tester normally used for the distensibility

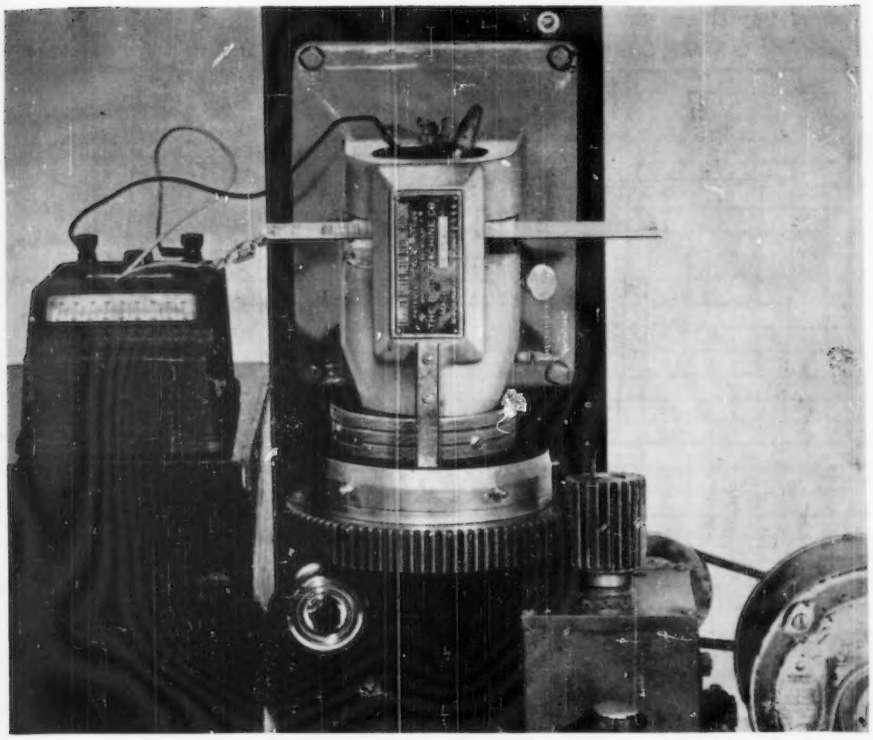


Fig. 6.—A General View of the Elongauge* Showing the Electrolyte End Point and Constant Speed Drive Attachment.

* Patents Applied for.

of paint films. Figure 6 shows a general view of the Elongauge with the electrolyte end point and constant speed drive attachment. The test panel is clamped between the die blocks with the paint film uppermost. One galvanometer lead is connected to the panel, the other is attached to the hypodermic needle. A small amount of water from a syringe is placed on the paint film and in contact with the needle. The tool or spindle is gradually pressed into the under surface, forming a bump or extrusion on the panel, and this expands the film. The paint film acts as an insulator. When it breaks, the water contacts the metal of the test panel. The bimetal couple established between the panel and the hypodermic needle causes current to flow. A deflection on the galvanometer signals the end point of the test.

The thrust of the tool or draw on the metal is measured in 0.01 mm. and is reported as the Elongauge reading.

In all the testing in connection with the Cleveland Club investigation, the paint films acquired hardness and loss of elongation with aging to such a degree that all could be tested for adhesion by the lateral stress method.

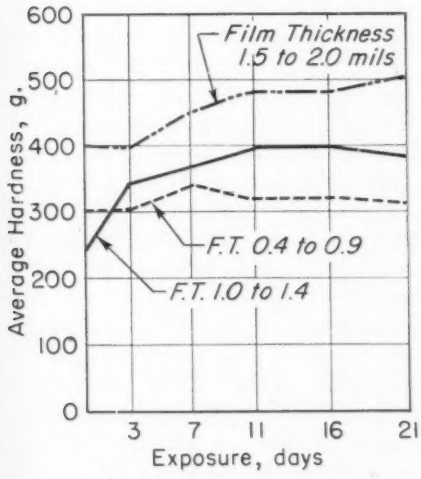


Fig. 7.—Effect of Film Thickness on Hardness Test Method. Miscellaneous materials on steel, air dry.

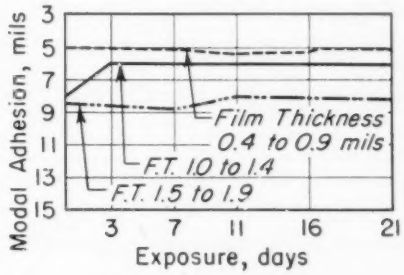


Fig. 8.—Effect of Film Thickness on Adhesion Test Method. Miscellaneous materials on steel, air dry.

Effect of Film Thickness:

What consideration has been given to the effect of film thickness upon the testing machine results?

The effect of film thickness upon the testing machine results has been investigated by the statistical method of taking either the arithmetical average or the modal average of test results taken over a period of a year on all types of material. The effect of film thickness within the range on the panels in this exposure test can be seen from Fig. 7 showing hardness readings, Fig. 8 showing adhesion readings, and Fig. 9 showing elongation readings. The frequency distribution was plotted in all cases, and the satisfactory nature of the average was determined by reference to the normal frequency distribution curve. In the exposure under discussion, the film thickness was controlled from one exposure medium to the next by having all the panels sections of a large panel sprayed at one operation. The conclusion from the hardness average is that hardnesses are directly affected by the film thickness on the basis of 75 to 100 g. per ½ mil of film thickness. The adhesion is definitely affected by film thickness as the modal average of the 0.5 to 0.9 mil group is 5½; 1.0 to 1.4 mils, 6; 1.5 to 1.9 mils, 8 to 8½. Elongation, on the other hand, is only slightly affected by film thickness when the film has achieved a through dry condition. It is believed that rather than cor-

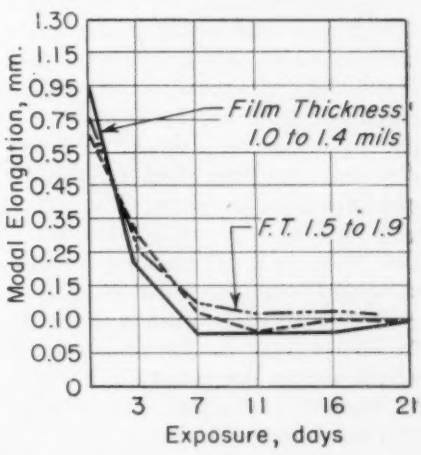


Fig. 9.—Effect of Film Thickness on Elongation Test Method. Miscellaneous materials on steel, air dry.

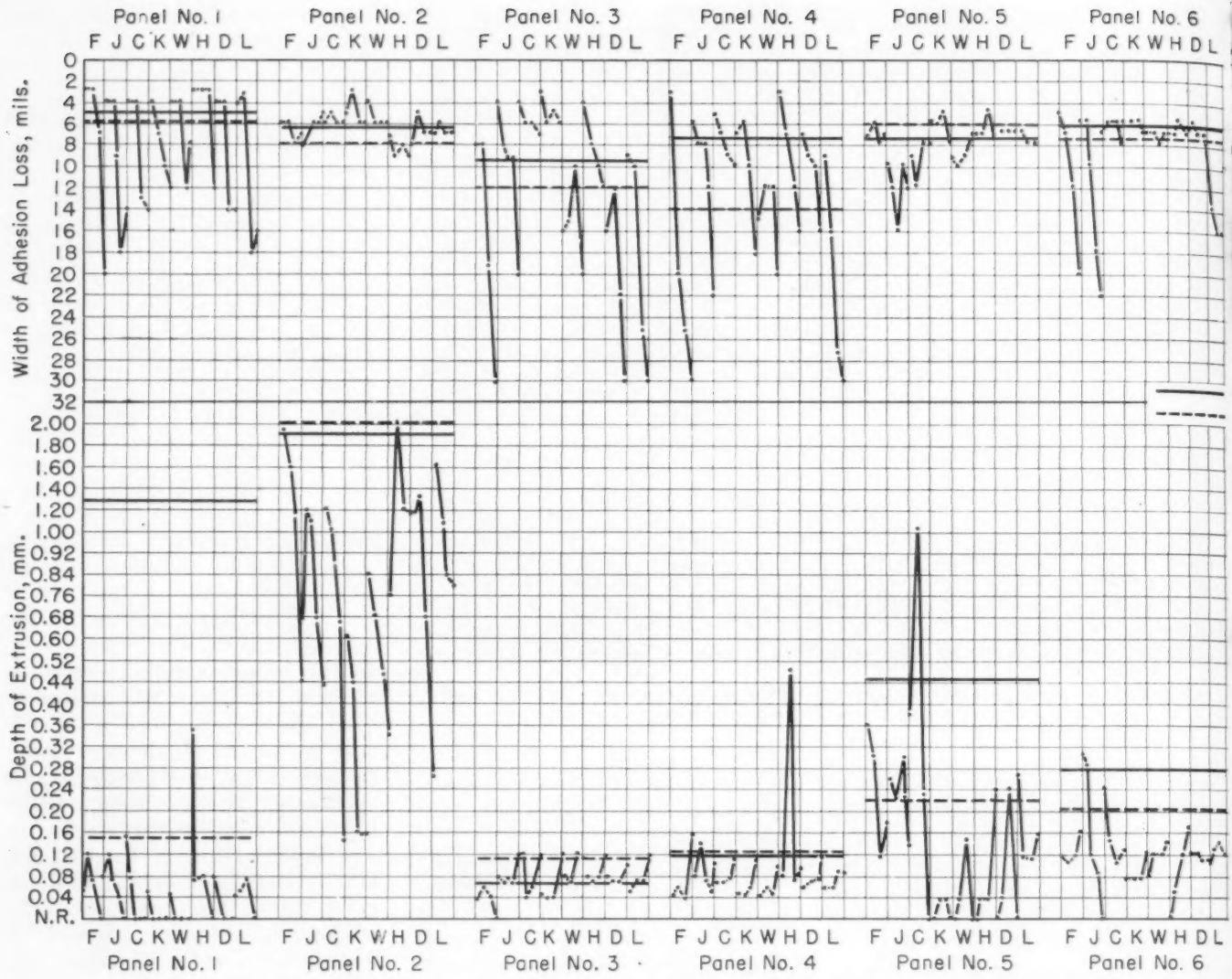


Fig. 10.—Composite Graphs of Adhesion and Elongation Readings at Outdoor and Machine Exposure Intervals

recting for differences in film thickness, it is best to record the actual machine reading on all properties and refer to experience tables such as the one which has been presented (Figs. 6, 7, 8).

If it is considered that the feasibility of using test machines to follow results of exposure through its effect on the physical properties of a paint film has been established, the complete machine data on the 13 panels of the Cleveland Club exposure can be reviewed to determine the correlation of laboratory accelerated tests with outdoor tests.

The visual correlation is available by reference to the previous paper[2] which shows the progressive effect of Florida, Cleveland, and laboratory machine exposure.

Graphic Presentation of the Adhesion and Elongation Test Results

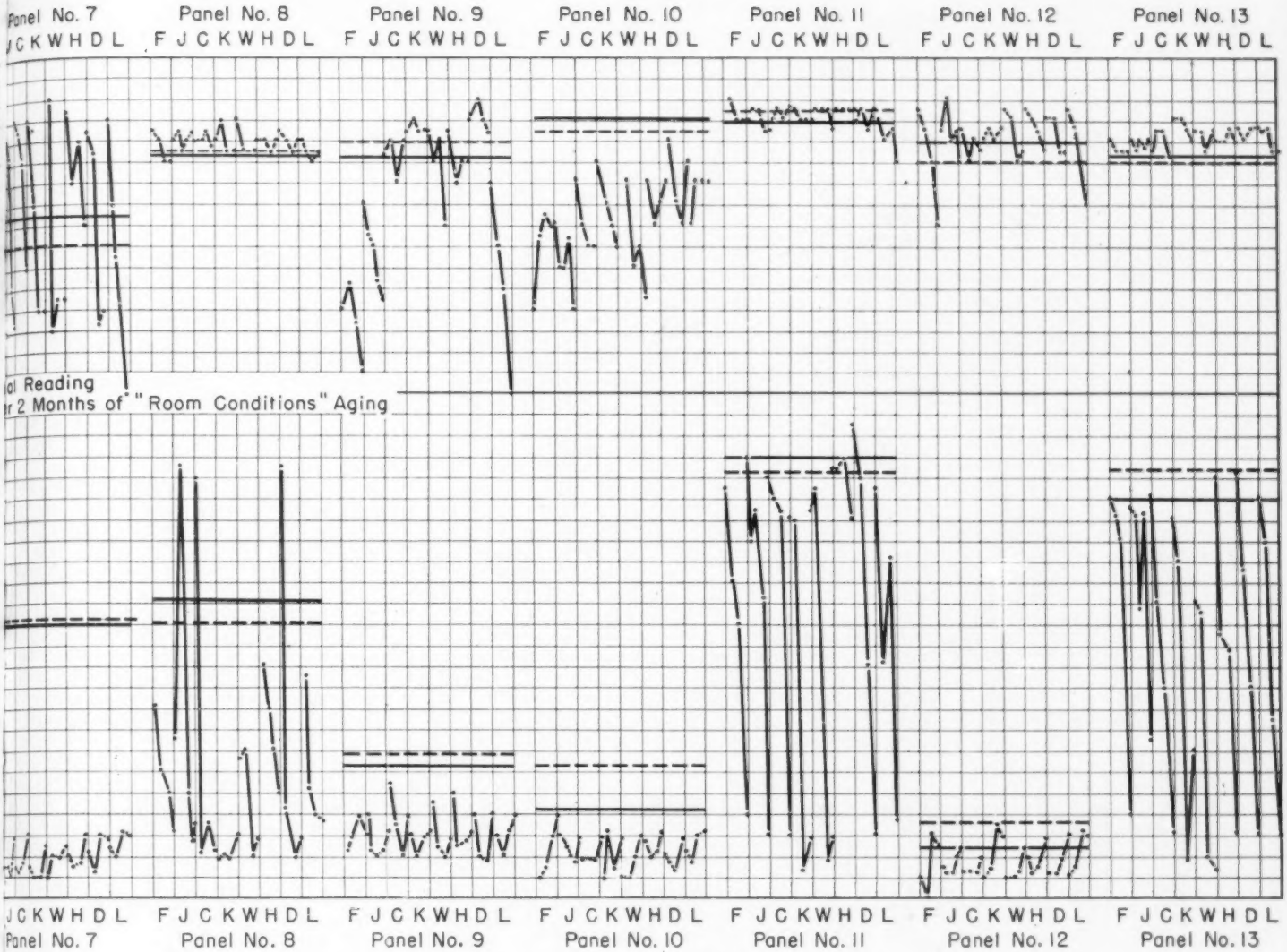
Figure 10 is a composite of testing machine results on the 13 materials selected for the simultaneous exposure. The effectiveness of distensibility or elongation measurement to summarize the results of each type of exposure is clearly shown by the widely different readings obtained on panel 1 as compared to panel 2, etc.

On Fig. 10, the change in paint films due to 2 months of indoor aging can be followed by referring to the solid horizontal line, which is the initial reading, and comparing it to the broken horizontal line which is a reading on the same panel after 2-month aging at "room conditions." In general, the effect of indoor aging has been slight, compared to even 7 days of machine or a month of outdoor exposure.

A conclusion of interest to technical people can be drawn at this time, to the effect that the application of laboratory tests, including salt spray, water immersion, humidity, reagent resistance or the like, would not be representative unless test panels had been exposed to at least 2 months of outdoor exposure or 11 days of weathering machine exposure before starting the laboratory tests. It is obvious that when physical properties do not change markedly with 2 months of indoor drying, but do change severely on short weathering, that those unstable and changing indoor dried films will respond to laboratory tests differently, depending entirely on the conditions previous to the application of the test.

Summary of Exposure Technique

The exposure technique used to insure accurate instrument testing conditions and to insure complete data for analyzing the anticipated difference in results of the various exposures is summarized below. Further details are given in the previous paper.[2]



Cleveland Club Paint Panels. For hardness readings refer to previous published paper.[2] [See Note in Fig. 1.]

Precautions Taken:

1. The weathering machines in this test were limited to the Cleveland area so that the water supplied to each machine would be from the same source. It is realized that Lake Erie water is almost an ideal source which could not be obtained in a nation-wide correlation effort.

2. The panels were from one batch of steel.

3. The panels were prepared by solvent washing with the final traces of solvent being evaporated from the face while baking the panel backing material 1 hr. at 300 F. This panel preparation would be considered as ordinary cleaning rather than special, yet sufficiently uniform to afford satisfactory adhesion of the paint materials.

4. The sample materials were selected by a committee which examined previously outdoor-exposed panels and selected from them the test finishes to give weathering failures on all the properties under consideration. By this procedure, 13 materials were selected, representing formulas from The Arco Co., Ferbert-Schorndorfer Co., The Glidden Co., and Sherwin-Williams Co. This procedure eliminated the possibility of obtaining biased results through biased selection of materials. Another practical feature of this method of selection was that completed formulas, considered for marketing, were used as the test materials.

5. No attempt was made to standardize the operation of the weathering machines, except that the arc light filters were to have already been used for approximately 100 hr. All other machine differences were measured and recorded in so far as practical.

6. The panels were shifted from the top to the bottom row alternately from day to day.

House paints were excluded from the test. Film thicknesses of only 1 mil were used to achieve rapid weathering and should not be translated into the actual performance to be expected from similar materials as applied in service. Formula information is provided in Table I, but no attempt was made to evaluate the use of one ingredient as compared to another.

Summary of Each Machine Exposure

Details for each exposure machine are given in Table II. The machine-exposure differences are:

1. The hot machines designated by the letters K, W, and C had a top temperature of over 175 F.

2. The cool machines were H and J. Machine H ran 125 F. or under and the machine J, 140 F.

3. The wettest was machine J, both during radiation and for 13 hr. of rotation with high humidity and intermittent wetting while the arc was dark.

TABLE I.—FORMULA BREAKDOWN ON CLEVELAND CLUB EXPOSURE.

Panel	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6	No. 7	No. 8		No. 9	No. 10	No. 11	No. 12	No. 13
										(Alkyd Vehicle)				
Type	Oleoresinous Graphic Red	Alkyd Chrome Green	Oleoresinous Red Transportation Enamel Pentalyn "A"	Oleoresinous Red Transportation Enamel RP 219 Durez	Alkyd Impedex	Phenol Impedex	Low-viscosity Alkyd Lacquer (Blue-white)	Primer: Red oxide Z.C. Ol. Top Coat: Soya-Glyceryl Ph. (1 g. Oil) Alkyd		Antimony-sulfide No. 4i Dk. O.D. Camouflage	Ultramarine blue Dk. O.D. Camouflage	Alkyd Green Enamel	Oleoresinous Green Enamel	Alkyd White Enamel
Film Thickness, mil	0.6 to 0.7	0.7	0.7 to 0.9	0.8 to 1.0	0.8 to 1.0	0.7 to 0.9	0.65	0.8 to 0.10		1.0 to 1.2	0.7 to 0.9	0.6	0.6 to 0.7	0.7
								Primer	Top Coat					
Vehicle, per cent	93.00	72.00	92.40	92.40	51.00	53.50	...	...	...	...	...	73.40	74.50	67.90
Pigment solids, per cent	7.00	28.00	7.60	7.60	49.00	46.50	10.00	48.8	38.0	48.0	42.9	26.60	26.60	32.10
Vehicle solids, per cent	50.00	67.00	51.00	51.00	44.9	49.20	32.83	27.3	19.6	17.6	18.8	50.00	35.70	34.60
Total solids, per cent	53.50	76.30	54.70	54.70	68.00	73.00	42.83	76.1	57.6	65.6	61.7	62.30	54.50	66.70
Pigment-binder ratio	1/7.1	1/2.3	1/6.7	1/6.7	1/1	1/1	1/3	1.9/1	3/1	2.8/1	2.2/1	1/2	1/1.3	1/1
PIGMENTS, PER CENT														
Titanium dioxide	...	...	...	...	7.3	7.5	10.0	9.6	5.7	...	...	?	?	100
Red oxide	7.0	...	...	...	...	...	...	15.1	...	...	3.2	...	...	...
Chrome green	...	13.7	...	...	...	...	...	...	...	...	...	?	?	...
Carbon black	...	0.6	...	...	...	...	...	...	0.5	...	...	...	...	...
Leaded zinc	...	2.2	...	...	...	...	...	...	...	...	...	...	...	...
Litharge	...	1.1	...	...	...	...	...	...	...	...	...	...	...	...
Magnesium silicates	...	10.4	...	...	...	...	...	...	17.0	...	...	...	...	...
Toluidine toner	...	...	7.6	7.6	...	...	...	...	...	...	...	...	...	...
Asbestine	...	...	...	...	12.1	10.8	...	...	...	13.26	13.26	...	...	...
Chrome yellow	...	...	...	...	...	...	...	11.5	...	6.59	3.92	?	?	...
Ultramarine blue	...	...	...	...	...	...	...	...	...	...	11.50	...	...	...
Impedex	...	...	...	...	26.7	29.0	...	...	...	...	...	...	...	...
Sienna	...	...	...	...	2.6	...	...	...	...	...	...	...	...	...
No. 72 zinc chromate	...	...	...	...	...	...	...	5.8	...	...	...	...	...	...
Acicular zinc oxide	...	...	...	...	...	...	...	...	14.8	...	...	...	...	...
325 mesh silica	...	...	...	...	...	...	...	6.8	...	13.92	13.92	...	...	...
Ferrite black	...	...	...	...	...	...	...	...	...	14.42	...	...	...	...
DRIERS, PER CENT														
Cobalt	...	...	3.3	3.3	...	1.5	...	0.14	0.14	...	...	...	...	...
Manganese	...	...	6.6	6.6	1.2	...	...	...	0.1	...	...	...	...	...
Lead	...	...	...	...	...	1.3	...	...	3.1	...	...	...	...	...
Con. Dk. manganese res.	...	...	...	...	...	...	...	2.1	...	...	...	...	...	...
Cobalt-manganese-lead	...	...	...	...	...	...	...	...	...	0.5	0.5	...	...	...
Anti-skinning agents	...	...	...	...	...	...	...	...	...	0.2	0.2	...	...	...
SOLVENTS, PER CENT														
Naphtha	46.5	...	...	...	...	6.8	...	...	...	9.75	15.52	...	?	...
Mineral Spirits	...	23.7	...	...	...	...	...	...	...	...	...	?	?	?
Varnolene	...	...	44.2	44.2	8.9	...	...	6.2	21.7	...	...	...	...	...
Xylol	...	...	...	...	...	8.2	28.8	...	...	6.88	6.88	...	...	...
Dipentine	...	...	...	...	...	6.5	...	...	1.8	...	...	...	...	...
Butyl acetate	...	...	...	...	...	...	13.0	...	...	...	...	...	...	...
Butyl cellosolve	...	...	...	...	...	...	5.0	...	...	...	...	...	...	...
Butyl alcohol	...	...	...	...	...	...	6.0	...	...	...	...	...	...	...
Water white kerosine	...	...	...	...	...	...	...	3.2	...	...	...	...	...	...
Solvesso No. 2 and No. 3	...	...	...	...	...	...	...	...	...	...	...	?	...	?
BINDER, PER CENT														
Alkyd	...	48.3 (73 linseed)	...	...	41.2 (45 alkyd)	...	...		35.2 (soya)	34.49 (linseed)	31.12 (linseed)	? (55 alkyd)	...	28.5 (linseed)
Oleo resin	46.5 (25 gal.)	...	50.0 (20 gal.)	50.0 (20 gal.)	...	43.1 (12.5 gal.)	...	39.6 (5 gal.)	...	...	...	...	? (5.6 gal.)	
Lac. alkyd	...	...	...	...	...	...	23.2 (cottonseed)	...	...	...	...	...	...	...
H-3 syntex	...	...	...	...	...	...	4.0	...	...	...	...	...	...	...
¼ Sec. cotton	...	...	...	...	...	...	15.0	...	...	...	...	...	...	...
Dibutyl phthalate	...	...	...	...	...	...	3.0	...	...	...	...	...	...	...

TABLE II.—RECORD OF EXPOSURE FACTORS.

		Arco J	Ferbert Schorndorfer C	Glidden K	Arco W	Ferro H	Sherwin Williams D	Florida F	Olmsted Falls L
Type of Machine		X-1A National Carbon	X-1 National Carbon	X-1A National Carbon angled panel rack	X-1 National Carbon	Single Arc Atlas BWMC	X-1 National Carbon		
Type of Carbons		Sunshine	Sunshine	Sunshine	Sunshine	Blueprint	Sunshine		
Distance (Arc to Panel), in.		19½	19	18¾	19½	14	18½		
Amperes		60	60	60	60	13	60		
Volts		230	230	230	230	130	230		
Age of Filters, hr.		3–230 3–190 2– 40	30	96	47	(Globe) 260	200		
Maximum Temperature Determined with Tempilstiks, 125, 150, 175 F. (on Back of Black Panels), deg. Fahr.	7 hr.	125	125 (trace at 150)	150	150	Below 125	125		
	3 days	125 (A.S.T.M. Black Panel 142)	175	175	175	125	150		
Length of Time Panel No. 6 is Completely Wet in a 2-Hr. Period, min.		21	6	26	18	22½ 7 revolutions	10		
Temperature of Water (Average for First 3 Days), deg. Fahr.		58	56	61	57	64	58		
24-hr. Cycle	Light, hr.	10	18	18	18	18	18		
	Water, hr.	24	18	18	18	24	18		
Color Change on National Bureau Standards Calibration Paper A	7-hr. dry (stationary) position	4×, increased red cast	3×, increased red cast	4×, increased red cast 2–3×, lighter	4×, increased red cast	2×, increased red cast	4×, increased red cast		
	7-hr. wet and dry (rotating)	2×, fade to bluer (retains red cast) 3×, lighter	2×, increased red cast 2–3×, lighter	4×, increased red cast 4×, lighter	3×, increased red cast 2–3×, lighter	3×, fade to bluer (no red cast) 3×, lighter	3–4×, increased red cast 3×, lighter		
	7-hr.—dry							3×, increased red cast ×, lighter	2–3×, increased red cast
	3 days wet and dry[a] (rotating)	4–5×, fade (retains 2 × blue - violet cast) 5×, lighter	4–5×, fade (retains 2 × red - violet cast) 5×, lighter	5×, fade to off-white with X-pink cast) 5×, lighter	4–5×, fade (retains X–2X blue-violet cast) 5×, lighter	3×, fade to bluer (no red cast) 4×, lighter	4–5×, fade (retains 2 × red - violet cast). 5×, lighter	4–5×, fade (retains 2 × red - violet cast). 5 × lighter	4–5×, fade (retains 2 × red - violet cast). 5 × lighter
	10 days								

[a] Arco-J has been exposed to approximately 33 hr. of arc as compared to approximately 51 hr. of arc on the others. Also, water runs continuously in the Arco J and Ferro H machines even after the carbons are burned out.

4. The driest were machines C and D, where the spray periods on panel 6 were only 6 and 10 min., respectively.

Conclusions

1. Inspection of the instrument testing indicates that machine exposure is very similar to the 45-deg. South Land Rack, located in Miami, Fla. Where adhesion was reduced outdoors, a like condition, except in the case of panel 12, was obtained by the use of at least one exposure machine, and in most cases, by all the machines. Elongation curves also demonstrate that the effect of exposure machines on panels is remarkably similar to outdoor weathering. Statistical correlation methods will be applied to the data at some later time.

2. Elongation readings were scattered in the machine exposures essentially in the order of the heat available to the panels. The cooler machines (over 125 and less than 175 F.) give results more nearly in the order of the outdoor exposure in Florida than do the other machines (see Fig. 10—panels 1, 2, 8, and 11).

3. The exposure machines do a good job of anticipating improvement or loss in adhesion by outdoor weathering, especially in the case of machine J as compared to Florida. There were eight panels which lost adhesion severely in Florida (1, 3, 4, 6, 7, 9, 10, and 12), and of this group the J machine picked seven (the case missed was panel 12). Moreover, machine J is the only one which indicated severe Florida adhesion loss on panels 6 and 9 (see Fig. 10—panels 1, 3, 4, 6, 7, 9, 10, and 12).

4. The committee was well satisfied[5] with the similarity of results in the machines which should have nearly duplicated each other (C and D). Where temperature was controlled, very uniform failure was achieved.

References

(1) R. M. Burns and A. E. Schuh, "Protective Coatings for Metals," Reinhold Publishing Co., New York (1939).

(2) H. A. Nelson and F. C. Schmutz, "Further Study of Accelerated Weathering: Effect of Variation in Exposure Cycle Combinations on Common Types of Varnishes," *Proceedings*, Am. Soc. Testing Mats., Vol. 24, Part II, p. 920 (1924).

(3) F. M. Damitz, "Adhesion, A Review," *Official Digest*, Federation of Paint and Varnish Production Clubs, May, 1945, Vol. 246, p. 213–228.

(4) Arnold J. Eickhoff and Richard S. Hunter, "Measurement of the Fading Rate of Paints," *Journal of Research*, Nat. Bureau Standards, Vol. 28, No. 6, June, 1942, p. 773. (*RP* 1478.)

(5) Ralph J. Wirshing, "Some Causes of Paint-Film Failure," *Industrial and Engineering Chemistry*, Vol. 33, February, 1941, p. 234–237.

(6) R. C. Krueger, L. W. Schaefer, and J. S. Long, "Pimpling of Automotive Enamel System," *Industrial and Engineering Chemistry*, Vol. 33, February, 1941, p. 239–245.

(7) C. Y. Hopkins, "Modern Methods of Paint Testing," *Official Digest*, Federation of Paint and Varnish Production Clubs, February, 1942, Vol. 213, pp. 94–101.

(8) "Symposium on Correlation Between Accelerated Laboratory Tests and Service Tests on Protective and Decorative Coatings," Am. Soc. Testing Mats. (1937). (Symposium issued as separate publication.)

(9) "Accelerated Weathering Tests of Enamels on Steel and Correlation with Outdoor Exposure," *Proceedings*, Am. Soc. Testing Mats., Vol. 40, p. 289 (1940).

(10) Henry A. Gardner, "Physical and Chemical Examination of Paints, Varnishes, Lacquers and Colors," 9th ed., Institute of Paint and Varnish Research, Washington, D. C., (May, 1939).

(11) H. A. Nelson and F. C. Schmutz, "Accelerated Weathering," *Industrial and Engineering Chemistry*, Vol. 18, December, 1926, p. 1222.

(12) H. A. Nelson, F. C. Schmutz, and D. L. Gamble, "Accelerated Weathering: Further Development of Apparatus and Exposure Cycles," *Proceedings*, Am. Soc. Testing Mats., Vol. 26, Part II, p. 563 (1926).

(13) F. C. Schmutz and D. L. Gamble, "Studies of Destructive Light Sources for Use in Accelerated Weathering Systems," *Industrial and Engineering Chemistry*, Anal. Ed., Vol. 1, April, 1929, p. 83.

(14) R. W. Matlack, "Current Procedures in Operating So-Called Accelerated Weathering Units," ASTM Bulletin, No. 131, December, 1944.

[5] The method of handling this localized cooperative exposure has lead to an attempt this year (with the identical materials) on a national basis. Members of Subcommittee VII of A.S.T.M. Committee D-1 at a meeting in Cleveland, were impressed with the advisability of correlating laboratory accelerated tests and out door tests by means of instrument testing for change in the physical properties of paints and are participating in further cooperative work.

DISCUSSION

Mr. Clinton Grove.[1]—Is it felt that the temperature at which the apparatus operates is a determining factor in the results obtained?

Mr. Dave M. Williams (*author*).—I do, very definitely. Subcommittee VII of Committee D-1 has set up a specification of 140 ± 10 F. on a black panel. The ambient air temperature of a machine is 30 to 40 F. below a black panel temperature. The reason for specifying temperature is due to its importance in the checking failure and also in the general life of the film.

Chairman C. H. Rose.[2]—Why were house paints omitted from the tests?

Mr. Williams.—Well, we wanted to work on steel panels, since they are better adapted to the present physical testing methods. The adhesion machine will work on a wood panel if the wood is firm enough. However, if it is too soft, it will drive down into the wood without uniformity. At present, I know of no method to check the distensibility of paint films on wood panels.

Mr. A. J. Eickhoff.[3]—Would any of the paints approach house paints in formulation?

Mr. Williams.—The closest formulation to house paint is panel 2. I should not say you would consider it house paint, but it is pretty much an oil vehicle.

Mr. E. J. Dunn, Jr.[4]—It is not entirely clear to me as to the operation for the measurement of elongation.

Mr. Williams.—If you are not familiar with the Erichsen machine, I can see how you would have difficulty following my explanation. The Erichsen machine is usually in a

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[2] Chemist, Research Labs., National Lead Co., Brooklyn, N. Y.

[3] National Lead Co., Brooklyn, N. Y.

[4] Research Laboratories, National Lead Co., Brooklyn, N. Y.

horizontal position. We have fastened ours on a board and brought it up in the vertical position so the observation hole or well is in a horizontal plane. We have replaced the steel orifice die with a plastic one such that when the test panel is in position, water can be applied to the surface of the paint. A wire from a galvanometer is connected to the copper hypodermic needle which is in the well and used to apply the water to the paint surface. The only reason you do not have the steel panel and the copper hypodermic needle causing a battery action in this salt water is the fact that you have a water barrier which is the paint film. When the paint film breaks, of course, the water instantly contacts the steel panel, causing a remarkably sudden electrical surge that shows on the galvanometer to indicate the film has opened to water penetration. This test end point has practical value since outdoors rust would start to cause film failure if a paint film broke under a deformation similar to the one applied by this machine.

MR. R. A. SHIVE.[5]—How long were the outdoor panels exposed?

MR. WILLIAMS.—A total of 4 months.

MR. SHIVE.—Did you run into any checking or cracking failure during the exposure period?

MR. WILLIAMS.—Yes. We ran into checking and cracking on panels 1, 3, and 4 outdoors and in the machines.

MR. SHIVE.—Could you give us some idea of the actual elongation of the exposed films?

MR. WILLIAMS.—It was very low. An accurate elongation test is not the answer on predicting checking. We feel that there is a certain sequence of readings which indicates a very likely panel for checking, but it does not hold up well enough to say that you can test for checkproofness by elongation.

MR. SHIVE.—I can see where you might have checking on one panel and no checking on another panel at the same elongation, but is there a point of elongation below which the films are likely to run into checking or cracking on exposure?

MR. WILLIAMS.—There is a number in connection with paints to go over wood, because you get a much greater coefficient of expansion across the grain there, but on steel, checking can be caused by expansion and contraction within a film itself. It seems to me in many checking cases that the reading indicates that there was sufficient elongation in the paint to stand the thermal expansion and contraction of the metal; but probably not enough in the top dried surface of the film to stand the expansion of the semi-dry portion underneath. That, too, is only part of the reason for checking being difficult to predict.

[5] Director of Technical Service, Pigment Dept., Calco Chemical Div., American Cyanamid Co., Bound Brook, N. J.

Measurement and Control of Interlaminar Resistance of Laminated Magnetic Cores

By R. F. Franklin[1]

SYNOPSIS

Magnetic circuits carrying alternating flux must be made of sheet steel laminations insulated electrically from each other in order to prevent the flow of interlaminar current which would cause high loss and excessive heat. The insulation is obtained by applying enamel, oxides, etc., to the surface of the sheet steel. To be effective the insulation must be a material that will withstand core operating conditions and must be applied in a satisfactory manner.

The instrument described in this paper was developed to test under simulated operating conditions insulating films applied to sheet steel in order to determine whether they are adequate and to make possible a practical method of quality control of their application.

The design of the instrument is quite simple and its operation very practical. A number of individual multiple contacts to which voltage is applied are pressed against the insulated surface of the sheet steel under predetermined conditions of voltage, pressure, and temperature. A measurement of the total current flowing through the contacts gives an indication of the value of electrical resistance of the insulating film under the conditions of the test. This method of testing and control of interlaminar resistance has been found more useful in most cases than the present A.S.T.M. method which utilizes a stack of Epstein punchings,[2] the resistance of which is measured with a bridge.

The core plate tester has been found of great value in the study and application of insulating films to steel sheets and punchings. It has been found useful not only for quality control of the application of enamel and oxide films to sheet steel but also for studying the effectiveness of these films under various operating conditions and when applied in various manners. In brief the tester is of inestimable value in the design and construction of magnetic cores.

MAGNETIC circuits designed to carry alternating flux are built up of thin sheets of magnetic steel in order to reduce the losses produced by the alternating flux. These losses are from two sources: one the result of resistance to change of the magnetic domains, called the *hysteresis* loss, and the other the result of resistance loss caused by the flow of eddy currents in the steel. This latter loss, which is called the *eddy-current loss*, is reduced or controlled by making the core of thin sheets of magnetic steel and introducing insulating material between adjacent sheets so as to limit or prevent the flow of eddy currents between adjacent sheets.

The usual method of obtaining in-

NOTE—DISCUSSION OF THIS PAPER IS INVITED, either for publication or for the attention of the author. Address all communications to A.S.T.M. Headquarters, 1916 Race St., Philadelphia 3, Pa.

[1] Motor and Generator Engineer Div., General Electric Co., Schenectady, N. Y.

[2] Standard Methods of Test for Magnetic Properties of Iron and Steel (A 34–44), 1944 Book of A.S.T.M. Standards, Part I, p. 679.

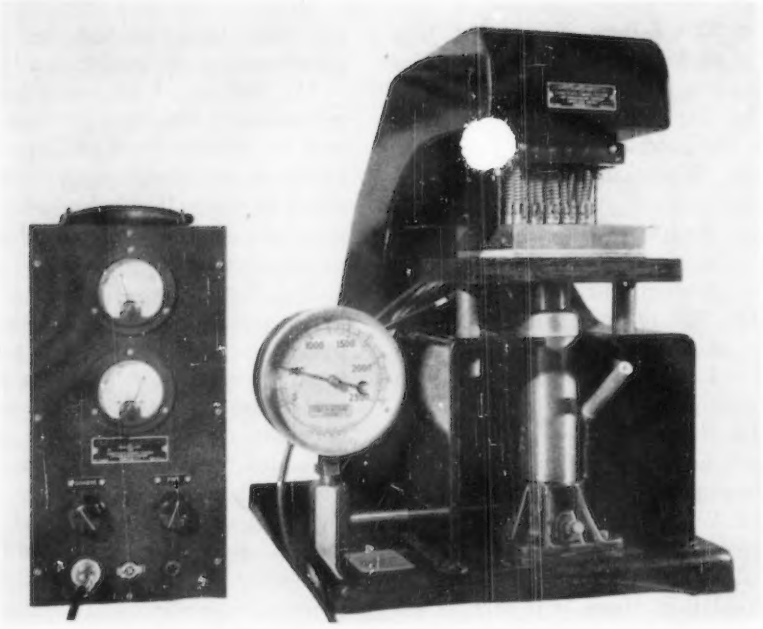

Fig. 1.—Core Plate Enamel Tester.

sulating material between the steel sheets or laminations is to coat the surface of the sheet with an insulating material such as enamel, varnish, paper, oxide, etc. The insulating enamel is usually applied to the sheets or punchings by means of rubber rolls after which it is baked in an oven. The insulating oxide scale is obtained by a controlled atmosphere anneal of the steel.

The physical characteristics of this interlaminar insulating material and the uniformity of its application are very important because if in a laminated core insufficient resistance is obtained, excessive eddy currents will flow between laminations resulting in high core loss and possibly high localized temperatures which may eventually destroy the insulating material and result in burning or fusing of the steel laminations themselves. To be successful, therefore, the interlaminar insulation must have the following qualities:

1. Must be a good electrical insulating material.
2. Must withstand core operating temperature without deterioration.
3. Must withstand physical clamping pressure of the core without flowing at operating temperature.
4. Must not be affected by oil, moisture, salt water, etc.
5. Must be applicable in a thin film, to obtain good space factor, having sufficient resistance to limit interlaminar loss to a low value.
6. Must be applied in a continuous thin film with a minimum of very thin or bare spots.

The above desirable properties may be grouped under two headings: first, inherent characteristics of the insulating material itself, and second, quality control of application. In the case of insulating enamels the first of these can be quite quickly and accurately evaluated by laboratory tests on the insulating material itself. The second, which is more difficult to evaluate, is of the utmost importance because a perfectly good insulating material, if improperly applied, will be practically worthless as an interlaminar resistance.

It is the purpose of this article to describe an instrument that has been developed, which makes it possible easily to control the application of an insulating material to the surface of the sheet steel by testing the surface insulation of the steel either in sheet or punching form under conditions simulating those in service. Hence the continued use of this instrument affords a method of setting up quality control for the application of the enamel or oxide so as to insure a high standard of interlaminar insulation in the core.

Prior to the development of this instrument the recognized method of testing the insulating value of interlaminar insulation was to apply the insulating material to a number of small rectangular pieces of sheet steel, stack them in a press and, by means of a bridge, measure the electrical resistance between top and bottom of the stack.[2] This method of evaluating the surface resistance is not very suitable for a rapid factory production test for quality control and is subject to possible error since when baking the enamel the amount of bake is dependent on the size of the sheet or punching which has to be heated during the baking cycle. Then, too, the surface bake of a large punching may not be uniform and this method could not take this factor into account. The apparatus described below quickly tests the surface of the individual sheet or punching and can be made at various places on the surface in order to check the uniformity of application.

Description of Core Plate Enamel Tester

The tester, which is more fully called a "Core Plate Enamel Tester," consists of a contact member which is fastened to the head of a hydraulic press and a control box containing the necessary meters, switches, rheostat, and battery. A photograph of the complete outfit is shown in Fig. 1.

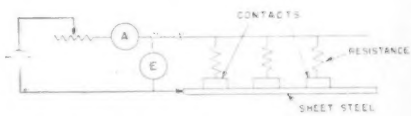

Fig. 2.—Wiring Diagram of Enamel Tester.

The contact member contains ten brass insulated contacts each of which is forced against the surface to be measured by a spring. There is in series with each contact a 5 ohm resistor so as to limit the short circuit current to a definite value when the contacts are short circuited by placing them on an uninsulated surface. The contacts and individual series resistances are all connected in parallel, as shown in Fig. 2, and connected across a definite value of d-c. voltage. The desired voltage is maintained across the terminals of the circuit by means

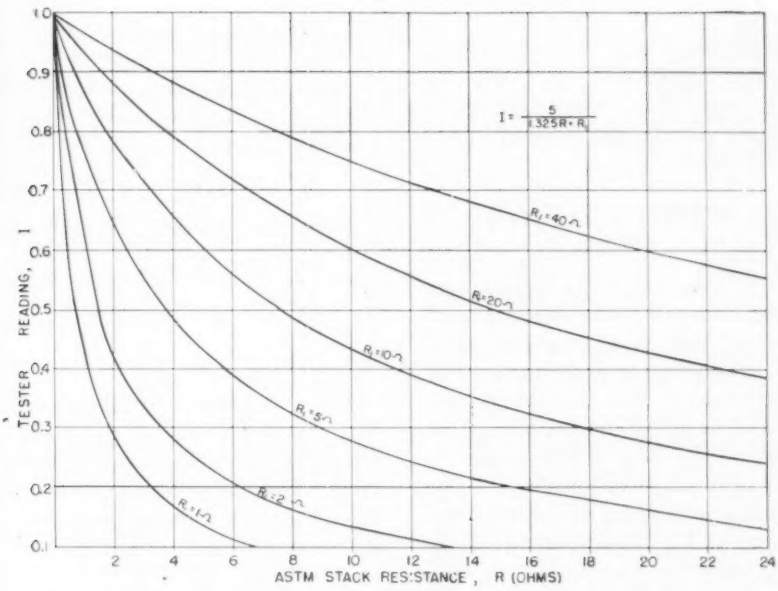

Fig. 3.—Relation Between Tester Reading and A.S.T.M. Stack Resistance.

of a dry cell, rheostat, and voltmeter. An ammeter in the line circuit gives the total current flowing through the contacts. Two twist drills which puncture the insulated surface when the contacts are pressed against the insulated surface complete the electric circuit.

The series resistances are chosen so that when the contacts are resting on an *uninsulated* surface and $\frac{1}{2}$ v. is applied to the terminals of the circuit the ammeter will read 1 amp. The range of current readings therefore will be from 1 amp. for an uninsulated surface to zero amperes for a completely insulated surface.

The instrument is fastened to the head of a hydraulic press so that pressure can quickly be applied on all contacts at the same time. In operation the punching is placed on a hot plate in the press which is held at a predetermined temperature simulating the core operating temperature. The press is then closed up and the pressure held at a predetermined value, which approximates the expected core pressure, until the punching comes up to temperature. The instrument circuit is then closed, the rheostat adjusted until the voltmeter reads $\frac{1}{2}$ v. and the ammeter reading recorded. The observed reading will fall between zero and 1.0, depending upon the quality of the surface film beneath the contacts, a reading of 1.0 being poor, a reading of zero being very good. Intermediate readings will give an indication of the quality of the film, the higher the reading the poorer the film.

A number of these surface resistance testers have been in use at the various plants of the General Electric Co. for two years and have proved valuable in the control of the quality of the surface resistance obtained on sheets and punchings insulated with oxide or enamel. A constant check is made of the insulated film immediately after application so that any failure in the process is immediately detected and the process discontinued until the cause of the failure found and remedied. The instrument has also proved valuable in the study of the formation of surface films of the oxide type. Because no easy means of obtaining a qualitative measurement of the resistance of these films was available in the past, the quality of the films was largely judged by color or probing the surface with a single contact. The use of this instrument has made possible a systematic study of the production of an oxide film of the resistance desired so that furnace temperatures, atmosphere, time, etc., can be predetermined and an immediate check of the product made. The instrument also makes possible a study of the effect of temperature, pressure, voltage, and time on the resistance of the surface film since all of these factors can be varied in the instrument over a considerable range.

Comparison of A.S.T.M. Method and Core Plate Enamel Tester

The present method of measuring the surface resistance of coatings on sheet steels is that of the A.S.T.M. method previously referred to. In this method 40 coated strips of sheet steel $1\frac{3}{16}$ by $9\frac{27}{32}$ in. are stacked up and the resistance of the stack measured under pressure with a bridge. The voltage per insulating film used in this method is considerably lower than that normally used by the tester method but if we assume that the resistance of the film is not affected by this difference in voltage a theoretical relation can be obtained between the two methods which will be helpful in correlating the readings taken by the two methods.

If we let R equal the resistance of the stack of strips in the A.S.T.M. method it can be shown that the resistance of the stack is

$$R = 6.88\,r \text{ (ohms)} \quad \ldots\ldots\ldots (1)$$

where r represents the unit resistance of the enamel film in ohms per square inch and the constant term results from the dimensions of the strips and the number of enamel films in the stack.

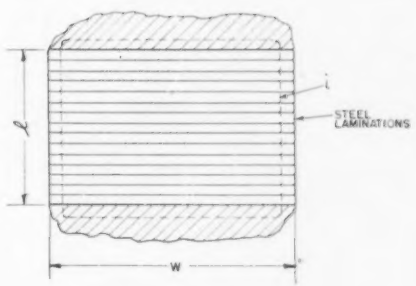

Fig. 4.—Cross-Section of a Laminated Magnetic Core.

If the core plate enamel tester has contacts $\frac{3}{8}$ in. in diameter and has R_1 ohms in series with each contact, the resistance of each contact circuit will be $\frac{r}{0.11} + R_1$. And if there are ten contacts in parallel the tester circuit resistance will be $\frac{1}{10}\left(\frac{r}{0.11} + R_1\right)$.

Assuming a voltage of $\frac{1}{2}$ v. the tester current will be:

$$I = \frac{0.55}{r + 0.11R_1} \text{ (amp.)} \quad \ldots\ldots\ldots (2)$$

Substituting Eq. (1) in Eq. (2),

$$I = \frac{5}{1.32R + R_1} \text{ (amp.)} \quad \ldots\ldots (3)$$

which gives the relationship between the readings obtained by these two methods.

The above equation is plotted in Fig. 3 for various values of series contact resistance and values of stack resistance from 1 to 24 ohms. As the maximum value of ammeter current varies with the amount of series resistance per contact, the ordinate for the various values of series resistance is expressed as a decimal of the maximum current. For the case of 5-ohm series resistance per contact, however, the ordinate becomes equal to amperes.

The curves in Fig. 3 show how various values of series resistance would change the resistance range of the instrument. The 5-ohm series resistance chosen for the instrument covers a resistance range in terms of the A.S.T.M. method up to about 30 ohms stack resistance, corresponding to a unit resistance of about 56 ohms per square centimeter per lamination, which values are usually considered quite low for resistance measurements made by the A.S.T.M. method. However, measurements made by the contact instrument are taken under somewhat more severe conditions so that the resistance values obtained are of a lower order and cannot be compared directly with those of the A.S.T.M. method. As will be shown later, these lower values are adequate even in the case of quite deep cores.

Effect of Surface Resistance on Loss

There exists an interesting correlation between tester readings and insulation loss in a magnetic core which is of value in determining the tester readings that should be expected in various applications. The expression for this relation can be briefly derived as follows:[3]

Assume a package of laminations as shown in Fig. 4 carrying an alternating flux perpendicular to the plane of the paper. An eddy current will be produced in these laminations as shown by the dotted line. The voltage acting on this path is:

$$e = \frac{d\phi}{dt} \times 10^{-8} \text{ (volts)} \quad \ldots\ldots (4)$$

where $\frac{d\phi}{dt}$ represents the rate of change of flux. If the flux is sinusoidal of maximum value B, the total flux enclosed by the eddy current path is

$$\phi = l\,WB \sin \omega t \quad \ldots\ldots (5)$$

Differentiating Eq. (5) and substituting in Eq. (4), the voltage becomes

$$e = \omega l\,WB \cos \omega t \times 10^{-8} \quad \ldots\ldots (6)$$

The effective value of this voltage is

$$E = \frac{2\pi f WlB}{\sqrt{2}} \times 10^{-8} = 4.44\ fWlB \times 10^{-8} \text{ (volts)} \quad \ldots\ldots (7)$$

where $2\pi f = \omega$.

Let ρ represent the resistivity of the enameled surface coating in ohms per cubic inch of laminations. Neglecting the resistance of the steel in the laminations the resistance of the eddy current path is

$$2l\rho \quad \ldots\ldots (8)$$

The loss in the eddy current path, which is $\frac{E^2}{R}$, is from Eqs. (7) and (8)

$$P = \frac{4.44^2 f^2 W^2 l B^2 \times 10^{-16}}{2\rho} \text{ (watts)} \quad \ldots\ldots (9)$$

Dividing Eq. (9) by $2l$, the length of path, the unit loss is given by

$$p = \frac{4.44^2 f^2 W^2 B^2 \times 10^{-16}}{4\rho} \text{ (watts per cubic inch)} \quad \ldots\ldots (10)$$

The next step is to calculate p in terms of the readings given by the enamel tester. The unit resistance of the enameled surface as obtained from Eq. (2) is

[3] A similar derivation is given in a paper by J. P. Barton called "Interlamination Resistance," *Transactions*, Am. Inst. Electrical Engrs., Vol. 63, September, 1944, pp. 670–672. A more classical calculation of the eddy current loss in a magnetic core is given in a paper by Bewley and Poritsky called "Intersheet Eddy-Current Loss in Laminated Cores," *Transactions*, Am. Inst. Electrical Engrs., March, 1937, p. 344.

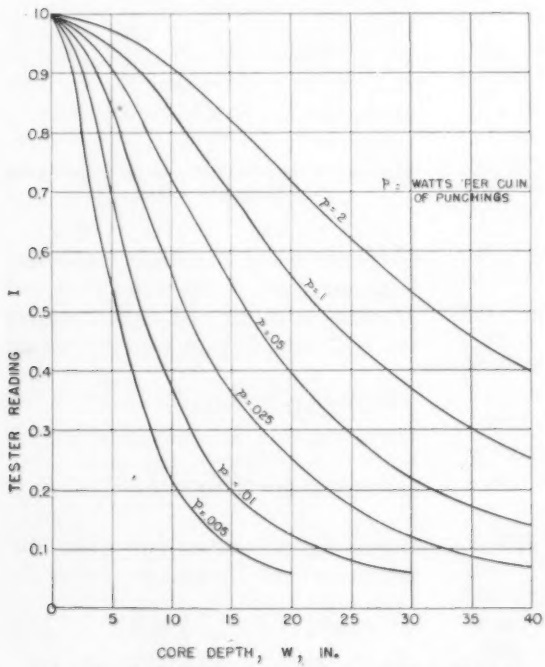

Fig. 5.—Interlaminar Loss *versus* Core Depth.

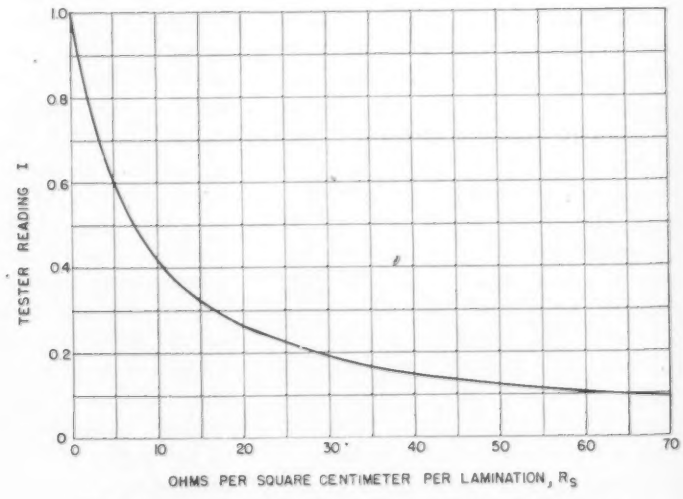

Fig. 6.—Tester Reading *versus* Unit Resistance.

$$r = 0.55\left(\frac{1}{I} - 1\right) \text{ (ohms per square inch)} \quad \ldots\ldots\ldots\ldots\ldots\ldots (11)$$

Now the number of laminations per inch of stacking is $\frac{k}{t}$, where t is the lamination thickness and k the stacking factor. Assuming each lamination enameled on both sides the number of enameled surfaces per inch of stacking is

$$\frac{2k}{t} \quad \ldots\ldots\ldots\ldots\ldots\ldots (12)$$

Hence from Eqs. (11) and (12)

$$\rho = \frac{1.1k}{t}\left(\frac{1}{I} - 1\right) \text{ (ohms per cubic inch)} \quad \ldots\ldots\ldots\ldots\ldots\ldots (13)$$

Substituting Eq. (13) in Eq. (10), the unit loss becomes

$$p = \frac{4.44^2 f^2 W^2 B^2 t \times 10^{-16}}{4.4\,k\left(\frac{1}{I} - 1\right)} \text{ (watts per cubic inch)} \quad \ldots\ldots\ldots (14)$$

The relation between p, W, and I for the case in which $f = 60$, $B = 90{,}000$, $t = 0.014$ in. and $k = 0.95$ is plotted in Fig. 5 as determined from Eq. (14). If one edge of the laminations is short circuited so as to offer negligible resistance to the eddy current flow the loss given in Eq. (14) would be multiplied by 4.

By the use of the data calculated in Fig. 5 it is possible to obtain an idea of the tester reading that would be desirable in order to limit the loss for a given surface insulation to a reasonable value. For example, if a steel of 1.0 watt per cubic inch is used at 90,000 lines per square inch density and it is desirable to limit the maximum eddy-current loss to 1 per cent of this value or 0.01 watt per cubic inch and the core depth is 10 in., the tester reading should be of the order of 0.35. These curves also show that with shallow cores only a small surface resistance is required while for deep cores a considerable higher surface resistance is desirable.

Tester Reading *versus* Unit Resistance

Another interesting relation is that showing the relation between the tester reading and the unit resistance per lamination. This relationship is given by

$$R_s = 7.1\left(\frac{1}{I} - 1\right) \quad \ldots\ldots\ldots (15)$$

where R_s is in ohms per square centimeter per lamination which is the unit used in the A.S.T.M. method. The above expression is readily obtained from Eq. (2) by substituting $\frac{R_s}{12.9}$ for the unit resistance r so as to convert it from ohms per square inch per film to ohms per square centimeter per lamination. The above expression for R_s is plotted in Fig. 6.

Inspection of Fig. 6 shows that the tester will give resistance measurements up to about 60 ohms per square centimeter per lamination which corresponds to a stack resistance of about 32 ohms. Thus to obtain very high values of core resistance the tester readings should be quite low. It should be remembered, however, that the interlaminar loss increases with the depth of core as indicated in Fig. 5 and that high resistance values are only necessary with very deep cores. This fact is clearly shown in Fig. 5 where for a core depth of only a few inches and a high tester reading, which corresponds to a very low core resistance as seen in Fig. 6, the loss is small. It is believed, therefore, that the resistance range of the tester, when taking into consideration the severe conditions under which the measurements are made, is adequate for the satisfactory design and manufacture of magnetic cores.

Value of Tester

The foregoing discussion describes the value of the surface tester to the engineer in the design, development, and quality control of the insulated surfaces of laminated magnetic cores. By the use of the tester the application of enamel to sheet steel can be accurately controlled and insulation values obtained that will be commensurate with the design and requirements of the core. The values obtained are truly qualitative so that it is no longer necessary to estimate or guess as to the adequacy of the resistance of the surface film. The use of the tester is, therefore, a vital factor in the manufacture of magnetic cores and marks an important contribution to the electrical art.

Discussion of Paper on "A New Method for the Mechanical Analysis of Soils[1]"

Submitted by C. M. Johnston[2]

The method of mechanical analysis of soils described by Raul Valle-Rodas in the August, 1945, issue of the ASTM Bulletin has some very desirable features such as (1) reduced time of soaking and sedimentation, and (2) elimination of the hydrometer.

The writer made a series of tests to compare the results obtained by this method with those obtained by two other methods, namely, the A.S.T.M. Standard Method of Mechanical Analysis of Soils (D 422 – 39),[3] and a method identical with the standard method except that the soaking period was reduced to a minimum of 1 hr. and the sedimentation period was limited to 1 hr. The modified standard method was included in the investigation in view of the frequently expressed criticism that the standard method which requires an 18-hr. soaking period and a 24-hr. sedimentation period is too slow for the use of construction inspectors. Reduction of the soaking period to 1 hr. and discontinuance of the test after a 1-hr. sedimentation period would be very advantageous if sufficiently reliable determinations of the clay content were obtained.

Four sandy soils, four silty soils,

[1] Raul Valle-Rodas, "A New Method for the Mechanical Analysis of Soils," ASTM Bulletin No. 135, August, 1945, p. 44.

[2] Associate Highway Engineer, Public Roads Administration, Washington, D. C.

[3] 1944 Book of A.S.T.M. Standards, Part II, p. 616.

and three clay soils were selected for the series of tests. Further diversification was obtained by selecting the soils from widely separated locations. Table I shows the states from which the samples were obtained and the physical constants of the soils. Triplicate samples of each soil were obtained by means of a riffle sampler. It has been previousy established that a riffle sampler will provide duplicate samples whose test results will be practically identical. Therefore, it is presumed that any variations shown in Table II for a given soil are due to procedural differences.

Table II shows the results of tests by the three methods. It will be seen that those obtained by the modified standard method, in which the samples were soaked for only 1 hr., are practically identical with those obtained by the standard method. The results obtained by following the Valle-Rodas procedure agree fairly well with those obtained by the standard method for the sandy and silty soils but vary quite widely on two of the three clay soils tested.

Considering that in the Valle-Rodas method the division between fine sand and silt is taken as 0.074 mm. (No. 200 sieve) instead of 0.05 mm. as in the standard method, the correlation between the two methods is surprisingly good. There is a definite trend in the Valle-Rodas method toward obtaining smaller percentages of sand and larger percentages of silt and clay than are obtained by the standard method. This is quite possibly due to a grinding action which may occur during the longer stirring periods prescribed by the Valle-Rodas method. The dispersion time in the hydrometer method of analysis, which was originally 15 min., was reduced to 1 min. for this reason.

It is believed that the large difference in percentages of fine sand obtained by the two methods on sample No. 70330 is primarily due to the difference in the size definition of fine sand. The sample was a mixture of a natural soil and ground quartz, both passing the No. 200 sieve (0.074 mm.). It is probable that a considerable portion of the sample consisted of particles having grain sizes between 0.074 and 0.05 mm. This portion of the soil would be determined as silt by the Valle-Rodas method and as fine sand by the A.S.T.M. standard method.

The following comparison of Valle-Rodas and the modified standard method (1-hr. soaking) illustrates their relative merits:

	Feature	Method	
		Valle-Rodas	Modified Standard
1.	Specific gravity determination required	None	Assume 2.65
2.	Temperature correction	None	From curve
3.	Hydrometer correction	None	From curve
4.	Specific gravity correction	None	None
5.	Computations	Simple	Easy with tables
6.	Soaking period	1 hr. (sand) 3 hr. (silt or clay)	1 hr.
7.	Dispersion period	5 min. (sand) 10 min. (silt or clay)	1 min.
8.	Sedimentation period	20 min.	1 hr.
9.	Siphoning period	1 min.	None
10.	Settling period after washing	30 min.	1 min.
11.	Total time in round numbers (exclusive of washing, drying, sieving, and computing, which are common to both)	2 hr. sand 4 hr. silt or clay	2 hr. all soils

TABLE I.—SOIL CONSTANTS AND MECHANICAL ANALYSIS OF THE SAMPLES USED IN THE COMPARISON TESTS.

Identification	State	Liquid Limit	Plasticity Index	Field Moisture Equivalent	Shrinkage		Sand		Silt	Clay
					Limit	Ratio	Coarse	Fine		
No. 70329	Va.	16	1	..	..	...	61	23	6	10
No. 70034	Ala.	26	9	..	..	...	55	23	4	18
No. 70142	Va.	17	4	16	14	1.9	43	27	12	18
No. 70144	Va.	24	5	28	19	1.7	45	28	14	13
No. 70330	Mixture	24	7	..	..	...	0	15	55	30
No. 69596	Md.	24	8	..	15	1.8	25	25	25	25
No. 70028	Ala.	30	14	22	16	1.8	14	12	41	33
No. 70047	Ala.	38	15	28	17	1.8	3	10	48	39
No. 69595	Md.	55	27	..	22	1.7	2	7	30	61
No. 69901	Va.	66	39	42	21	1.6	25	13	14	48
No. 70053	Ala.	83	47	56	17	1.8	1	9	20	70

TABLE II.—MECHANICAL ANALYSES BY MODIFIED STANDARD, STANDARD, AND VALLE-RODAS METHODS.

Soaking Time	1 hr.	18 hr.	Valle-Rodas	1 hr.	18 hr.	Valle-Rodas	1 hr.	18 hr.	Valle-Rodas	1 hr.	18 hr.	Valle-Rodas
Sandy Soils												
Sample	No. 70329			No. 70034			No. 70142			No. 70144		
Coarse sand, per cent	61	61	56	54	55	52	42	43	39	45	45	40
Fine sand, per cent	24	23	26	24	23	24	28	27	26	28	28	24
Silt, per cent	5	6	8	4	4	5	13	12	17	14	14	20
Clay, per cent	10	10	10	18	18	19	17	18	18	13	13	16
Silty Soils												
Sample	No. 70330			No. 69596			No. 70028			No. 70047		
Coarse sand, per cent	0	0	0	24	25	24	14	14	12	3	3	3
Fine sand, per cent	17	15	3	27	25	22	11	12	9	11	10	5
Silt, per cent	53	55	61	25	25	26	42	41	39	47	48	46
Clay, per cent	30	30	36	24	25	28	33	33	40	39	39	46
Clay Soils												
Sample	No. 69595			No. 69901			No. 70053					
Coarse sand, per cent	2	2	1	26	25	23	1	1	1			
Fine sand, per cent	6	7	1	12	13	11	8	9	5			
Silt, per cent	29	30	26	13	14	14	17	20	13			
Clay, per cent	63	61	72	49	48	52	74	70	81			

While the above time schedule shows that 2 hr., exclusive of the time necessary for washing, drying, sieving, and computing, are required for making each test by the modified standard method, it is possible to test fifteen samples concurrently and complete all of the tests in an 8-hr. day by overlapping the operations in the procedure. Our limited experience with the Valle-Rodas method indicates that by taking advantage of the possible overlapping of operations, ten samples of sandy soil per 8-hr. day is the maximum number that can be tested.

The Valle-Rodas method requires a minimum of equipment and eliminates correction factors. The temperature and hydrometer corrections required by the modified standard method may be made during the progress of the test if curves, tables, or a special slide rule are available. Final calculations are about the same with either method of test, with the Valle-Rodas method having a slight advantage.

For field use and few tests per day, it is believed that the Valle-Rodas method would be advantageous, but for laboratory use and instances where volume production is required, the modified standard method appears preferable.

Mr. RAUL VALLE-RODAS (*author's closure by letter*):

I wish to thank Mr. C. M. Johnston for the favorable comments on my paper. In Mr. Johnston's discussion, there are a few points, however, that need to be clarified, regarding the soaking and stirring periods, the number of tests per 8-hr. day, etc.

Soaking Time and Stirring Period:

In the Atlantic Road, which is being built here in Nicaragua, Central America, by the Public Roads Administration, we were using the author's suggested method for the classification of soils, and the results thus obtained were compared with the ones obtained by the A.S.-T.M. Standard Method.[3] Most of the soils in this road are clayey soils with high percentages of colloidal material (called "sonsocuite" soils by local engineers).

TABLE III.—RESULTS OF TESTS.

Sample	Material	Analysis, per cent		
		Soaking: 18 hr. Stirring: 1 min.	Soaking: 1 hr. Stirring: 1 min.	Soaking: 1 hr. Stirring: 10 min.
No. 242	Coarse sand	6	5	3
	Fine sand	6	6	6
	Silt	13	12	10
	Clay	75	77	81
No. 253	Coarse sand	6	6	3
	Fine sand	10	10	7
	Silt	19	18	20
	Clay	65	66	70
No. 252	Coarse sand	3	5	2
	Fine sand	7	7	6
	Silt	13	14	13
	Clay	77	74	79
No. 186	Coarse sand	8	9	5
	Fine sand	29	26	19
	Silt	33	35	26
	Clay	30	30	50
No. 182	Coarse sand	8	8	6
	Fine sand	18	17	8
	Silt	38	38	27
	Clay	36	35	59

We found out in performing the tests what Mr. Johnston has already pointed out, namely that changes in the soaking period do not greatly affect the final results. Soaking the samples for a 1-hr. period is enough for almost all soils, even for the highly colloidal clays, like the "sonsocuite" soils. For this reason, we considered it advisable to reduce the soaking period to 1 hr. for all soils. (See Procedure 5 (*b*) of the Suggested Method.)

Changes in the stirring period, however, do affect the final results. That is why, in order to avoid the grinding action which occurs during long stirring periods, we have also reduced the time of stirring to 1 min. for all soils. (See Procedure 5 (*c*) of the Suggested Method.)

Several tests were made in this regard, varying the soaking and stirring periods. The results of some of these tests are shown in Table III.

The results, as we can see, are practically the same when changing the soaking period from 18 hr. to 1 hr., but they change quite widely when the stirring time is increased from 1 min. to 10 min. This seems to explain the variations obtained by Mr. Johnston in two of the soils referred to in his discussion.

As shown in Table III, it seems advisable to reduce the time of soaking and the stirring period. For this reason, we recommend to take, when using the author's suggested method, as the soaking period: *1 hr. for all*

TABLE IV.—COMPARISON OF STANDARD AND SUGGESTED METHODS.

Sample	Liquid Limit, per cent	Plasticity Index	Material	Analysis, per cent	
				Standard Method	Suggested Method
No. 234	58	24	Coarse sand	11	11
			Fine sand	16	15
			Silt	17	17
			Clay	56	57
No. 234A	92	54	Coarse sand	13	17
			Fine sand	9	8
			Silt	15	11
			Clay	63	64
No. 223	71	41	Coarse sand	20	19
			Fine sand	19	18
			Silt	20	20
			Clay	41	43
No. 225	50	24	Coarse sand	31	33
			Fine sand	24	21
			Silt	16	15
			Clay	29	31
No. 227	58	30	Coarse sand	21	20
			Fine sand	13	14
			Silt	16	13
			Clay	50	53
No. 246	64	34	Coarse sand	14	15
			Fine sand	17	19
			Silt	25	21
			Clay	44	45
No. 8	100	65	Coarse sand	3	4
			Fine sand	7	5
			Silt	11	10
			Clay	79	81

soils, and as the stirring period: *1 min. for all soils.*

Tests on Clayey Soils:

For sandy and silty soils the results obtained by the suggested method are practically identical with those obtained by the Standard or Hydrometer method.[4] By reducing the stirring period to 1 min. for clays, the grinding action was avoided and the results obtained were as good as the ones obtained for sandy and silty soils. Table IV shows the close relationship between the results obtained on clayey soils, some of them with a high colloidal content, by means of both methods: the Standard Method, and the one suggested by the author. (Tests were performed at an average room temperature of 86 F.)

Settling Period after Washing:

Although it was indicated, in the suggested method, to let the removed material stand for about half an hour before oven-drying, this step is necessary only when an excess of water is present. However, this can be avoided by removing the material carefully, so that no excess of water will be present.

Procedure, Computations, Laboratory Records, Time of Performance:

The simplicity of the suggested method is one of its major advantages. Tests could be made with a minimum of equipment. Likewise, by avoiding the previous determination of the specific gravity and the use of correction factors, computations are so simple that they could be done very rapidly, without even the use of an ordinary slide rule. There is no need of charts or diagrams, and the recording of the test data is also greatly simplified because the percentages of sand, silt, and clay are obtained directly. Besides, by reducing the time of soaking and stirring, the time of performance will be cut down to 1 hr. 20 min. for all soils, against 19 hr. for the Standard method and 2 hr. for the Modified Standard proposed by Mr. Johnston.

More Than 50 Samples per day Could Be Tested by the Suggested Method:

Mr. Johnston's estimation of the number of samples that can be tested with the suggested method is extremely conservative. In our laboratory, with limited equipment, one person has been testing by overlapping the operations in the procedure, 20 samples in a period of 2 hr., exclusive of the time necessary for drying and sieving. This means that in any United States soils laboratory, at least *50* samples per 8-hr. day can be tested by one person (providing that there are enough beakers). With the Modified Standard, and the Standard Methods, 15 samples will be about the maximum that can be tested per 8-hr. day.

In order to test many samples a day by using the suggested method, it is recommended that a large number of samples be already soaked, before starting the tests, so there will be no delay in the testing procedure.

The great number of samples that can be tested by means of the author's suggested method constitutes a record mark, and we hope that its use will be of some help to laboratory men and construction engineers

Relative Merits:

The relative merits of the different methods are shown in Table V, in which the author's suggested method is compared with the Standard and the Modified Standard method proposed by Mr. Johnston.

TABLE V.—COMPARISON OF THREE METHODS.

	Standard Method	Modified Standard	Suggested Method
Specific Gravity Determination	Necessary	Necessary	Not necessary
Hydrometer Use	Necessary	Necessary	Not necessary
Temperature Correction	Required	Required	Not necessary
Specific Gravity Correction	Required	Required	Not necessary
Hydrometer Correction	Required	Required	Not necessary
Soaking Period	18 hr.	1 hr.	1 hr.
Sedimentation Period for Clay Determination	1 hr.	1 hr.	20 min.
Stirring Period	1 min.	1 min.	1 min.
Computations	Charts or a special slide rule are needed		Very simple. Neither charts, nor slide rule are necessary
Total time in round numbers (exclusive of drying, sieving or computing)	19 hr.	2 hr.	1 hr. 20 min.
Number of samples tested per 8-hr. day work	.....	15	50 or more.

[4] In the suggested method, silt is taken as the material passing sieve No. 200 (74 microns) instead of sieve No. 270 (53 microns), because sieve No. 200 is more widely used in U. S. laboratories and foreign countries. However, if the division between fine sand and silt is to be taken as 0.05 mm., sieve No. 270 should be used.

Summary of Lecture on the Combination of Data from Tests Conducted at Different Laboratories, by P. C. Mahalanobis, F. R. S.

As reported by J. Tucker, Jr.[1]

EDITOR'S NOTE.—An informal lecture on "The Combination of Data from Tests Conducted at Different Laboratories" was given by Prof. P. C. Mahalanobis, F. R. S., Editor of the Indian Journal of Statistics, *SANKHYA*, at the National Bureau of Standards as the first of the Allied Mathematics Colloquium Series, on November 13, 1946. The following report on this lecture was prepared by Mr. John Tucker, Jr., a member of Committee E-11 on Quality Control of Materials.

PROF. MAHALANOBIS stated that the problem involved the precision of measurements in which he first became interested some 24 years ago when given the task of investigating certain discrepancies in correlation between pilot balloon measurements of upper air pressures and temperatures. In computing the correlation coefficients, he had thought it advisable to introduce terms for errors of measurement into the equation for the correlation coefficient. Thus instead of:

$$r = \frac{1}{n} \Sigma \ (x_i - \bar{x})(y_i - \bar{y})$$

[1] National Bureau of Standards, Washington, D. C.

he used:

$$r = \frac{1}{n} \Sigma (x_i + \epsilon_i - \bar{x})(y_i + \eta_i - \bar{y})$$

where ϵ and η represent errors of measurement. The use of this latter equation introduces new product terms:

$$\Sigma \epsilon_i y_i; \ \Sigma \eta_i x_i; \ \Sigma \eta_i \epsilon_i$$

in addition to the usual terms of the form $\Sigma x_i y_i$.

The usefulness of this treatment of the data was established by the fact that the meteorological results reached by him were independently arrived at eight or nine years later by Franz Bauer from entirely different considerations.

This experience had prompted several questions:

1. Two rods of different lengths, say one approximately 5 cm. long and one 30 cm. long are each measured 500 times with an ordinary steel scale divided into 1-mm. divisions. Will the standard error of the measurements of the two rods be the same?

He did not find any critical discussion of the problem; at least, not in literature available to him a few years ago.

2. Length and diameter measurements are made on a rod of circular cross-section. Would the standard error of each of such measurements be the same, or would the errors in the two measurements be independent or correlated?

The earlier temperature and pressure studies indicate that this question is important, as terms of the type $(\epsilon_i \eta_i)$ would be negligible only when there was no correlation between such errors.

3. Prof. Mahalanobis then referred to the fact (pointed out, for example, in Shewhart and Deming's book,)[2] that values of such fundamental constants as the velocity of light, the ratio of the charge to the mass of an electron, gravitational constant, Planck's constant, etc., as measured in different laboratories actually differed in most instances by as much as three to eight times the calculated standard errors. In some cases the exact definition of the constants might be considered to be somewhat different, but such a line of explanation was scarcely possible in the case of the gravitational constant or the velocity of light.

Three possible explanations for the differences obtained in the measurements made by different laboratories are suggested:

1. There is some "bias" leading to statistically significant differences in the results.

2. The Gauss-Laplace curve of errors may not apply rigorously.

3. Slight intraclass correlations may exist between measurements made by the same observer or within the same laboratory. For example, when measuring a rod with a scale, successive readings may not be statistically independent. If there is any intraclass correlation, then the variance of the mean would be given by $\sigma^2/n[1 + (n - 1)\rho_n]$ instead of σ^2/n. Now $(n - 1)\rho_n$ will tend to be zero even when n is large, provided ρ_n is truly zero. But when there is any intraclass correlation, however small, it is inevitable that the term $(n - 1)\rho_n$ would not be negligible when n is sufficiently increased, and would ultimately become the dominant term when n is large. In this latter case the true error would be appreciably greater than the calculated error. In other words, there may not be a biased error, but an increased margin of error due to the readings being correlated. Besides this, as already mentioned, there was also the question of how far the normal curve of errors is really adequate.

Prof. Mahalanobis had attempted to collect some preliminary data bearing on the above points. He got a number of students of physics to make measurements of rods of different lengths with four different types of steel measuring scales. On one scale the centimeter marks were unequally spaced but each centimeter was divided into 10 equal parts. In the second the scale had true centimeter graduations but the centimeters were divided into ten slightly unequal graduations, and the third scale was a combination of the foregoing two. The fourth scale was just an ordinary scale. In tests with these measuring rules it was found that using the one with uniform graduations the students' measurements yielded a curve which is much more peaked than the Gauss-Laplace curve. With scales having the nonuniform graduations the observed curves were more widely dispersed. This suggests that the precision of modern measuring instruments has now become so great that personal equation or bias (which was previously negligible) cannot be ignored any longer. It might therefore be advisable to use measuring instruments with nonuniform graduations (with a table of corrections) in order to eliminate bias.

Discussion:

The lecture was followed by general discussion.

The variables, such as shape of specimen, particularly the shape of the end, and length, which affect the observed length values, were cited.

Prof. Mahalanobis cited an experiment that he would like to have performed. This would consist of, say, a set of two or three Kater pendulums placed in different locations in the National Bureau of Standards, and a similar set of two or three placed in, say, his university in Calcutta. Observations would be then made at each station for an extended period with several observers rotating among the two or three stations and the results from the several stations compared.

There was considerable discussion of the normal curve as representative of the universe of observational errors. One speaker contended that all this had nothing to do with mathematical statistics.

Prof. Mahalanobis replied that he was in complete agreement with Klein's view that there was an unbridgeable gulf between pure and applied mathematics. Methods of pure mathematics were no doubt most useful and even essential in statistics as in physics and other scientific subjects, but recourse to such mathematical methods must always be an act of faith to be justified by the purely pragmatic criterion of whether any useful result was reached or not. For example, no physicist would have any hesitation in using the integral calculus to calculate, say, a moment of inertia but he would know that matter was not continuous in the sense re-

[2] W. A. Shewhart and W. E. Deming, "Statistical Methods from the Viewpoint of Quality Control," The Graduate School, The Department of Agriculture, Washington, D. C. (1939).

quired by pure mathematics, and therefore the use of analytic methods could never be established with logical rigor. He submitted therefore, that investigating the appropriateness of particular mathematical methods or models was an essential part of the job of a statistician; and he further contended that statistics being essentially an applied science, such investigations must proceed on definitely experimental basis.

A question was propounded to Prof. Mahalanobis as follows: What is the procedure when samples are taken at different locations from a bale of rubber, and a number of tests are made from samples at each location. He explained that this type of problem in which the quality of material would probably differ with the location of the sample was no doubt most important but was entirely different from the situation which he was discussing, namely, one in which each group of observations is taken upon samples from what is believed to be the same universe, the variables being the observer and place of observation or the measuring apparatus, the *measuring apparatuses* being as nearly alike as we can make them.

Summary (Comment by J. Tucker, Jr.):

Prof. Mahalanobis' lecture dealt with errors of measurement, with particular emphasis upon systematic errors. He has studied this by making observations on the one error the same quantities by a number of measuring machines (all close duplicates) set at different locations, and these measuring machines operated by a number of observers. He has also studied the effect of using varied and nonuniform scales to eliminate personal bias, such as a tendency to record even rather than odd numbers in the last estimated place.

His approach is to build up from experiment, compared to the school of statistical thought which mathematically postulates or creates a hypothetical universe, with which data are compared.

His background as a student of physics gives him perspective of the physical world which unfortunately is lacking in many otherwise capable statisticians.

Fire-Retardant Properties of Treated Felt

THE active work by a Task Group assigned to study the flame-retardant properties of felts is illustrated by that done recently under the auspices of Subcommittee A-3, Section II on Felt, of A.S.T.M. Committee D-13 on Textile Materials.

Four laboratories (three manufacturers and one consumer) ran inter-laboratory tests on varied grades and thicknesses of felt in the flameproofed and the untreated state. The need for a special method and specification differing from the A.S.T.M. Tentative Specfications for Fire-Retardant Properties of Treated Textile Fabrics (D 626 – 41 T) was apparent as felt is thicker than the usual textile fabrics and has no yarn structure.

While all the treated felts tested passed the requirements of the accompanying proposed specifications, sufficient variation in inter-laboratory data on measurement of after-glow was found to prevent adoption of either the method or the specifications by the committee. The proposed specifications are published as information for the purpose of soliciting constructive comment from other organizations and those interested in this subject who may have had experience with this or similar types of tests when applied to felt.

Proposed Specification and Method of Test for Fire-Retardant Properties of Treated Felt

This proposed specification and test method are published as information only. Comments are solicited and should be addressed to the American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa.

Scope

1. This specification applies to the fire-retardant properties of felts treated to be fire retardant.

PROPOSED SPECIFICATION

Fire-Retardant Properties

2. The felt, when subjected to the test described in Sections 5 and 6, shall conform to the following requirements as to fire-retardant properties:

(*a*) *Duration of Flaming.*—There shall be no initial surface flash. The continuation of flaming for any one of the five specimens after removal of the igniting flame shall not exceed 2 sec.

(*b*) *Duration of Glow.*—The felt shall not propagate a flame. The duration of glow, which is also noted by smoldering of sample after flame is removed, shall not exceed 30 sec.

PROPOSED METHOD OF TEST

Sampling

3. A sample of not less than one 1 linear foot across the full width of roll of felt shall be selected for test. The sample shall be brought to standard condition which is that reached by the fabric in moisture equilibrium in an atmosphere having a relative humidity of 65 per cent at 70 F. (21 C.). A tolerance of plus or minus 2 per cent is permitted in relative humidity and plus or minus 2 F. (1.1 C.) in temperature.

Test Specimens

4. (*a*) Five test specimens each 4 in. in width by 6 in. in length shall be cut from at least three widely spaced sections of the sample.

(*b*) Five specimens shall be tested.

Apparatus

5. The apparatus shall consist of the following:

(*a*) *Clamp.*—A suitable clamp for suspending the test specimen above the flame and capable of so holding the specimen to prevent it from moving after being clamped in position for test.

(*b*) *Shield.*—A sheet metal or plywood shield 12 in. in width, by 12 in. in depth, by 30 in. in height, all inside dimensions, shall be used to protect the test assembly from drafts. The shield shall be open at the top and provided with a vertical sliding glass front. Sufficient opening (1 in. in height and 5 in. in length) shall be left at the bottom of the front to allow for manipulation of the gas burner.

(*c*) *Gas Burner.*—A bunsen burner with a tube $\frac{3}{8}$ in. in diameter.

Procedure

6. (*a*) *Duration of Flaming.*—The test specimen shall be suspended vertically $1\frac{1}{2}$ in. above the top of the gas burner and clamped so that a 6-in. length of the material is exposed to the flame. With the air supply completely shut off, the burner shall be adjusted to give a luminous flame $1\frac{1}{2}$ in. in length. The flame shall be applied vertically near the middle of the width of the lower end of the specimen for 30 sec., then withdrawn, and the time during which flaming continues on the specimen shall be measured and recorded.

(*b*) *Duration of Glow.*—After the gas flame is removed, and immediately after the test specimen stops flaming, the time of glow shall be measured and recorded.

America's Fabrics

The stated purpose of this book by Zelma Bendure and Gladys Pfeiffer is "to give as complete a story as space permits of all fabrics in consumer use from their beginnings to finished fabrics." The volume is divided into 22 chapters. One of these is an introduction; eight deal with the various fibers used in textiles manufacture; five describe the various processes employed in making yarns and fabrics; one presents those fundamentals of chemistry thought to be necessary for an understanding of modern textiles; four outline the various treatments and finishes used on fabrics; one discusses fabrics used for home furnishing; one is a fabric dictionary including nearly 200 items; and one gives a very brief résumé of the use and development of methods for the identification of fiber content and the study of fabric characteristics. A good index completes the book.

An outstanding feature of this book is the inclusion of many unquestionably fine illustrations, of which there must be about 600, although they are not numbered. Most of these are excellent photographs and many are very real reproductions of fabrics. Twelve are color plates. Like the illustrations, the chapters also are not numbered. In both cases this lack is an inconvenience to the reader when referring to another section, especially since the authors refer to chapters by number, which necessitates consulting the Table of Contents. Another inconvenience to the reader is the fact that nearly a third of the pages of text are not numbered due to the arrangement of the illustrations. This becomes especially troublesome when as many as 11 consecutive pages bear no numbers.

The scope of this book is wide. The organization of subject matter is not complicated, and both type and style of writing make for easy reading. It is intended especially for persons who work with fabrics, for students, and for consumers, but not for fabric technicians. Considering the range of subject matter, undoubtedly some differences of opinion will arise concerning many statements which are included. In the opinion of the reviewer some duplication and repetition of statements could have been omitted. Also it would have been desirable to have checked carefully for contradictions which exist within the text, for precision in the use of terms, and for the accuracy of statements in many cases. The statement on page 447 that "Wool is composed chiefly of keratin, which is an amino acid" is an illustration in point. In the event that this book is revised many corrections should be made.

This 688-page publication is available from The Macmillan Company at $10 per copy.

Ethel L. Phelps

Galvanizing Handbook

This profusely illustrated and well-organized handbook on galvanizing by J. R. Daesen will be of interest to those in this field of activity. The author deals first with the mechanism of protective action and the typical structure of a zinc coating. He then discusses the effect of variations in the iron or steel base and the control of fluidity of the coating with temperature and with the addition of aluminum, tin, and other metals. He also discusses the effect of the handling after dipping and heat treatment of the coatings, as well as the details of cleaning, pickling, and fluxing.

The information given in this book will certainly enable the galvanizer to locate almost any difficulty he might encounter in his process, and to improve the quality of his product.

This publication is available from the Reinhold Publishing Corporation, New York City, at a cost of $5.25 per copy.

Book on Reagent Chemicals and Standards

Recently off press is the second edition of "Reagent Chemicals and Standards" by Joseph Rosin, Chief Chemist and Chemical Director of Merck & Co., Inc. This latest edition contains requirements and tests for fifty-two new reagents which include such special materials as several of the more important amino acids. The authoritative position of this work on the requirements and tests for reagent chemicals has been generally recognized since it was issued in 1936. Reference to this book for requirements and tests for reagent chemicals is made in the A.S.T.M. Tentative Recommended Practices for Apparatus and Reagents for Chemical Analysis of Metals (E 50 – 46 T), which are under the jurisdiction of the A.S.T.M. Committee E-3 on Chemical Analysis of Metals. Copies of this 550-page publication, clearly printed on good paper and sturdily bound in a durable cover, are available at $7.50 per copy from D. Van Nostrand Co., Inc., 250 Fourth Avenue, New York, N. Y.

Highway Research Board Proceedings

The Proceedings of the Twenty-Fifth annual meeting of the Highway Research Board have been issued. This 506-page book includes a large number of technical papers and reports which are segregated under the following sections: Design; Materials and Construction; Maintenance; Traffic and Operations; Soils Investigations; and Special Projects. The papers under Materials and Construction cover such subjects as identification of granular deposits by aerial photography, condition of concrete pavement in Kansas as affected by coarse aggregate, pavement blowups correlated with source of coarse aggregate, temperature variations in a concrete pavement and the underlying subgrade. Under Soils Investigations there are such topics as sand compaction studies at Eglin Field, Florida, abuttments for small highway bridges, transfer of earth pressures by shearing stresses, theoretical aspects of water accumulation in cohesive subgrade soils, and some problems in subgrade moisture control. Copies of this publication can be obtained from the Highway Research Board, 2101 Constitution Ave., Washington, D. C. at $5.00 each.

Inter-Society Color Council Meeting

The next annual meeting of the Inter-Society Color Council is to be held in New York City, February 24 and 25 in conjunction with the meeting of the Optical Society of America and the Technical Association of the Pulp and Paper Industry. The Monday discussion to be held at the Pennsylvania Hotel involves morning and afternoon sessions which will cover problems under investigation by Council committees, including the following: Color Terms; Color Aptitude Test; Color Blindness Test; Illuminating and Viewing Conditions for Colorimetry; the Illuminant in Textile Color Matching. On Tuesday, February 25, at the Commodore Hotel the technical session sponsored jointly with T.A.P.P.I. will include the following papers: The Paper Man's Interest in Color, A. H. Croup; Colorimetric Standardization in Industry, Ralph M. Evans; Color-Order Systems, Carl E. Foss.

The afternoon session at 2:00 p.m. will consist of the following: Spectrophotometry, Norman Barnes; I.C.I. Standard Observer and Coordinate System, J. A. Van de Akker; Inter-Relation of Color Specifications, Dorothy Nickerson; Color Engineering, Frederick H. Rahr. All those concerned with color are cordially invited to attend the Council meetings.

A.S.T.M. is one of the thirteen national associations which belong to the Inter-Society Color Council and a number of A.S.T.M. members have had a very active part in the work.

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JANUARY 1947

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NINETEEN-SIXTEEN
RACE STREET
PHILADELPHIA 3, PENNA.

Notes on A.S.T.M. Publications

ABOUT the time that this January BULLETIN should go in the mails three parts of the 1946 Book of A.S.T.M. Standards will have been completed: Part I-B became available in early January, and Parts II and I-A were to be finished late in that month.

As all members know, the 1946 Book of Standards comprises the major portion of the heavy publication schedule on which substantial progress is being made by the staff. By the middle of May the Society will have issued some 13,000 to 15,000 pages of material, the big Book of Standards comprising about 7000 pages of this amount.

The 1946 Book is being issued in five Parts, as follows:

Part I-A—Ferrous Metals
Part I-B—Non-Ferrous Metals
Part II—Nonmetallic Materials—Constructional
Part III-A—Nonmetallic Materials—Coal and Coke, Petroleum Products, Aromatic Hydrocarbons, Soaps, Water, Textiles, Gaseous Fuels
Part III-B—Nonmetallic Materials—Electrical Insulating Materials, Plastics, Rubber, Paper, Shipping Containers, Adhesives.

Special compilations of standards (which books in some cases include other pertinent material) that have recently been completed include those pertaining to petroleum products and lubricants, glass and glass products, and steel piping materials, sponsored, respectively, by Committees D-2, C-14 and A-1. Orders for these books received from the members and others are being filled as rapidly as possible. Even many members who have available the big Books of Standards find it convenient to get these special compilations.

Other technical publications on which work has been or will shortly be completed include the 1946 Marburg Lecture by Dr. Mattiello, involving Protective Organic Coatings as Engineering Materials, the Symposium on Oil Procurement Practices, and the Symposium on Bearings. Descriptions of these publications have been forwarded to the members. The two symposiums are considered outstanding contributions in their respective fields. Another publication being issued in separate pamphlet form is the paper on Theory of Adhesives, by Dr. Weyl.

While work is under way on the 1946 *Proceedings*, which will probably aggregate in excess of 1600 pages, instead of the estimated 1300 pages, there is no likelihood that this will be completed before the end of April. Meanwhile quite a number of the major items in the *Proceedings* will have been published in separate pamphlet form.

Fiftieth Annual Meeting

WHILE the general theme of the Society's Fiftieth Annual Meeting to be held at Chalfonte-Haddon Hall, Atlantic City, during the week beginning June 16, is to be "Fifty Years of Progress and the Outlook for the Future," the meeting program will include numerous technical sessions of particular interest to specific groups in the Society. It is not possible at this stage of planning to do more than note some of the topics under development. Further details will appear in the March BULLETIN, and the provisional program for the meeting with the synopsis of technical papers and related information is scheduled for the May BULLETIN, the last one issued prior to the meeting.

In connection with work on soils there are two potential features, one the symposium on load tests to determine bearing capacity of soils, with a separate session involving papers on soils in general. Committee D-18 is planning these particular programs. There is a round table discussion on identification of water-formed deposits, thus continuing the interesting discussions on this general subject that have been arranged by A.S.T.M. Committee D-19. Another session that is very likely to be set up involves fatigue testing, with a series of papers. Other topics under consideration involve rubber and rubber products which would be covered by papers presenting data developed during the war period and a discussion on speed of testing. There are a number of other topics being studied by Society groups to determine whether the 1947 Annual Meeting would be the appropriate time for presentation of papers and reports on the respective topics.

The very successful dinner sponsored by the Western New York-Ontario District during the 1946 Annual Meeting in Buffalo has prompted a decision to hold another Annual Meeting Dinner in Atlantic City, with the cooperation of the Philadelphia District.

Nominating Committee Correction

ON page 52 of the December 1946 BULLETIN there was an error in the list of *ex-officio* members of the 1947 Nominating Committee for A.S.T.M. officers. The name of Past-President H. J. Ball was incorrectly included—this should have been P. H. Bates. Messrs. Dean Harvey, P. H. Bates, and J. R. Townsend as the three immediate Past-Presidents serve as *ex-officio* members of the Nominating Committee. The listing of the regular members and the respective alternates as given in the article was correct.

A Pertinent Message to All of Us from the President[1]

As we close the first full peacetime year since 1940, it is a welcome privilege to greet you and to express my wish that the New Year will bring to each of you a larger measure of happiness, success, and prosperity.

The prompt return of normal activities for which most of us hoped a year ago has been delayed, but slowly a foundation is being laid on which we can build more firmly than ever before if we adhere to the fundamental principles of cooperation with each other, justice for all, and willingness to work. Our country emerged from the war greatly impoverished, although many of our people have suffered from the illusion of increased riches and prosperity because of higher wages and freer money. Actually, the impoverishment is apparent in the shortages of basic raw materials, the scarcities of manufactured goods, and the lowered initiative and productivity of our workers, all of which have seriously retarded our recovery. With relaxation of government controls and a greater return of business to the American system of free enterprise, progress in the coming year should be more rapid if we can learn to utilize fully the improved methods, new discoveries and better equipment now available and to work together efficiently to restore our lost wealth. The imperative need is for production which can be attained only by cessation of the industrial conflicts of the past year and by a real desire on the part of both management and labor to be just in their dealings with each other and with the public which they serve.

Our Society has for many years demonstrated the advantages which may be attained by cooperative effort and by seeking justice for all. In developing standards for materials and methods for measurement of their quality, consumers and producers have met and smoothed out differences which might well have become very serious in hampering industrial progress. Such standards properly applied are powerful instruments for the assurance of justice. By keeping alert to new methods, processes and materials, by promoting research, and by incorporating these advances in industrial standards, our committees are constantly aiding in the betterment of human welfare. It is obvious therefore that the part which our Society can play in helping the recovery from war presents an unparalleled opportunity which I am sure we will eagerly grasp in the year ahead.

Your Officers, Directors, and Headquarters Staff have worked diligently during the past year to assure the adoption of sound policies and their proper implementation so that we may be in a position to serve most effectively. To this end we have expanded our physical facilities by moving into the enlarged space provided in the splendid new headquarters building. In addition, we are reorganizing and expanding our administrative and technical staffs in accordance with previously announced plans. These changes have been accomplished with very little interference of our regular operations and in fact, were made while an expanded publication schedule was in progress.

Forward-looking policies with respect to technical expansion are in process of being carried out. A new study committee is working to organize activities in the field of the so-called "Sandwich Construction" materials, and administrative committees are continuing the work on Ultimate Consumer Goods and Simulated Service Testing. New technical committees are being formed in such fields as Engine Antifreezes and Asbestos-Cement Products. A very strong committee on Statistical Quality Control has taken over the previous activities on presentation of data and the establishment of tolerances and is expanding into the broader field indicated by its name. Nearly all of the technical committees are vigorously at work in their respective lines now that peace is here. Membership in our Society is now well over 6000 and our able Membership Committee has many plans envisioning further growth. Service to our members through the various districts is being improved by a change in type of organization. The past record of our Society is great and our wartime contributions were outstanding, but it is my firm belief that we are ready for even greater accomplishments ahead.

Financially, our position remains strong; but the greatly increased level of all costs coming at a time when expansion is a necessity is imposing a strain which must not be permitted to weaken our future. Already some adjustments in prices of our publications have been necessary because of increased printing costs, and undoubtedly further measures to increase the income of the Society will be recomended by the Finance Committee in the near future. In view of the importance of the services rendered by A.S.T.M. and their value to industry, your Board of Directors believes that these burdens will be willingly assumed by our membership, with the assurance that the same careful stewardship as in the past will be exercised to avoid waste or extravagance and to render full measure of service.

It is with this background that we in A.S.T.M. look forward to the New Year. The Officers and Staff appreciate the splendid support you have given and we hope that together we can make 1947 a banner year for us all.

Sincerely yours,

Arthur W. Carpenter

[1] While the essence of this message was sent to the members early in January with their annual statement covering dues, we feel the sentiments and philosophy expressed so pertinent that the message is reprinted here in somewhat expanded form. Furthermore while the message is intended primarily for members of the Society, it should be of interest to all who read the BULLETIN.—The Editors.

A.S.T.M. Building Fund Continues to Grow

In response to the advice from the Board of Directors that additional funds were needed if the new Headquarters Building was to be held cleared of encumbrances a number of additional companies and individuals have made contributions to the fund. The accompanying list shows those contributions received from November 19 to December 20. The officers of the Society have been very gratified by the response of so many members, both individual and company, to the fund, a total of about $160,000 having been contributed.

It is the hope that many of the contributors will find it possible to visit the building particularly during A.S.T.M. Committee Week beginning February 24. On Wednesday, February 26, the Building is to be formally dedicated and in connection therewith there is to be a dinner and ceremonies at the Benjamin Franklin Hotel, beginning at 7:00 p.m.

Companies Contributing to the Building Fund from November 19–December 20

Accurate Springs Mfg. Co.
American Society for Metals
Arundel Corp., The
Cutler-Hammer, Inc.
Detroit Edison Co.
Gates Rubber Co.
Hall, C. P., Co., The
Houdry Process Corp.
Iron Age, The
Jefferson Chem. Co., Inc.
Jenkins Bros.
Lubrizol Corp., The
National Assoc. Dyers & Cleaners
Newport Industries Inc.
North Jersey Quarry Co.
Precision Thermometer & Inst. Co.
Riverton Lime & Stone Co., Inc.
Sprague Elec. Co.
United Chromium, Inc.

Personal Members Contributing to the Building Fund from November 19–December 20

Alesi, Anthony L.
Ball, Herbert J.
Barr, Joseph R.
Bateman, John H.
Bittenbender, Robert A.
Bolton, John W.
Callan, Philip J., Jr.
Carlson, Thorwald A.
Dietz, Albert
Dodge, Ralph L.
Eppley, Marion
Grotlisch, V. E.
Haydock, Charles
Jones, L. B.
King, Albert D.
MacDonell, Hubert F.
Miller, Walter
Murphy, Glenn
Moulton, M. O.
Nead, J. H.
Newton, Victor
North, R. S.
Osborne, Raymond G.
Osbourne, Alan
Perry, R. W.
Peters, Fred P.
Porter, Earl H.
Reeve, C. S.
Schmidt, E. F.
Schofield, L. B.
Smith, H. E.
Speller, F. N.
Statler, A. W.
Swain, Stephen W.
Townsend, J. R.
Tour, Sam
Weiss, A. E.
Wunderlich, M. S.

Forthcoming District Meetings

New York: Testing of Consumer Goods; Western New York–Ontario: Automotive Fuels and Rubbers; Philadelphia: Cotton Fabrics and Processing; Meetings in both Pacific Coast Districts.

At least five meetings are to be held in the next few weeks under the auspices of A.S.T.M. District Councils in certain industrial centers, including Rochester (Western New York-Ontario), Philadelphia, New York, and the two Pacific Coast districts. In connection with the latter affairs, President Carpenter and Executive Secretary Warwick are making a trip to the West Coast, and the districts have arranged the meetings in conjunction with this trip. A few details of the respective meetings are noted below, and a general invitation is extended to all A.S.T.M. members and guests to attend. Further details of the meetings will be given in direct mail notices to A.S.T.M. members in the various areas involved.

New York, March 4—Testing of Ultimate Consumer Goods:

The meeting in New York at the Engineering Societies Building on the evening of March 4, beginning at 7:30 p.m. will feature an address by Mr. Gerald C. MacDonald, Manager of Quality Control, Montgomery Ward & Co., Chicago. Mr. MacDonald has devoted intensive effort to the evaluation of the wide range of products handled by his company, and has been vitally concerned with many problems in connection with so-called ultimate consumer buying. He has participated in the work of a number of organizations and in A.S.T.M. is a member of the Administrative Committee on Ultimate Consumer Goods which has considered the activities and policies which the Society should set up in this field. In addition to Mr. MacDonald's address, Mr. Ephraim Freedman, Director, Macy Bureau of Standards, R. H. Macy and Co., Inc., New York, who is the meeting program chairman, has in mind inviting other authorities in this field to present discussion.

This meeting is the second in a series of three which are planned by the New York District Council. The third one, probably to be held in the early fall, will involve certain phases of television.

Rochester, March 13—Automotive Fuels and Rubber:

Inasmuch as there has been no A.S.T.M. meeting in Rochester since the very successful national spring meeting of the Society held there in 1938, the Western New York–Ontario District has been planning, through its Rochester contingent, to arrange for a technical session, and have enlisted the cooperation of the Rochester Engineering Society. An interesting session is scheduled for the evening of March 13. From the beginning, the plan has been to feature discussions on materials or elements in the automotive field, and the committee is pleased that the Society's senior Vice-President, T. A. Boyd, Head, Fuel Dept., Research Lab. Div., General Motors Corp., will speak on Gasoline—Yesterday — To-day — To-morrow. With him in the technical program will be Mr. B. P. Nesseger, The B. F. Goodrich Co., who will discuss a number of interesting phases in the development and use of automotive rubber. Mr. Boyd, an outstanding authority in this field and in other phases of research has spent many years of his industrial career in studies of automotive fuels.

Philadelphia, March 25—Cotton Fabrics and Processing:

For some time the Philadelphia District has wished to sponsor a technical session on some phase of textiles, feeling that there would be a definite interest in such a meeting, and support from many of the textile companies located in the Philadelphia area. Dr. G. E. Landt, President, Philadelphia Textile Finishers, Inc., and Secretary of the Philadelphia District is developing, as chairman of the textile program committee, a most interesting session to be held at the Franklin Institute on March 25, which will feature two or three leading technologists, speaking on textile fabrics and their processing, in particular cotton textiles. Further announcement of this meeting will be made.

Pacific Coast Meetings—March 10 and March 18:

In San Francisco on March 10 and in Los Angeles on March 18, A.S.T.M. President Carpenter will address technical meetings in those cities, as arranged by the Northern and Southern California District Councils of the Society. The meeting in San Francisco is to be a joint one with the California section of the American Chemical Society. At both meetings Mr. Carpenter plans to discuss technical progress in industry. Further details of these two meetings at which Executive Secretary Warwick will also be present will be furnished to the Society's West Coast membership.

Five Hundred Attend New York Meeting on Future of Atomic Energy

WHEN Myron Park Davis, Chairman of the New York District, opened the meeting on "The Future of Atomic Energy" at the Engineering Societies Building on Thursday, December 12, there were close to five hundred people present, just nicely filling Room 501. It is presumed that everyone present felt repaid for his attendance because the speaker, Dr. John R. Dunning, Professor of Physics, Pupin Laboratories, Columbia University, gave a most interesting and instructive talk. He is that much-to-be-desired type of speaker who has an authoritative knowledge of his subject, yet can get across the points he wishes to stress in an entertaining fashion. His talk took about an hour and a half and was supplemented with a number of interesting experiments and demonstrations.

The Program Committee, headed by C. T. Hatcher, Consolidated Edison Co., who introduced the speaker, and the New York District officers will retain vivid recollections of the meeting, not only from its very successful outcome but for other reasons: first, that Dr. Dunning, on the morning of the day in which he was to speak, was compelled to be at Oak Ridge, Tennessee, but did catch a plane which despite bad flying weather enabled him to arrive at the informal dinner just in advance of the meeting; then, the equipment he was to use had been forwarded from Canada and was only cleared through the Customs at about five o'clock on the afternoon of the meeting. These close connections kept the committee on edge.

Prior to Dr. Dunning's talk Mr. Davis introduced Executive Secretary C. L. Warwick who extended greetings from the Society officers and complimented the District on arranging the meeting.

The speaker covered his subject essentially in three parts: first, giving a background of the development, then the present status of the whole situation, and finally a look into the future. He pointed out that man had been dealing with this source of energy for many years, and by energy he meant nuclear energy, not atomic energy, since the latter is really a misnomer. Chemists and physicists have been able to transmute practically all of the elements into other forms, and while there is a close relation between chemical and nuclear reactions the great difference is in the magnitude. For example, a nuclear process might result in one million times as much energy as would result from the chemical process.

The real problem in connection with nuclear energy was to get an exothermic reaction which would be self-sustaining. After years of work one of the first breaks in the series of studies came when a Berlin physicist noted the peculiarity of the reaction of uranium with certain other elements. The next problem was to determine which of the uranium atoms was responsible for

Using a Very Costly Pellet of Radium-Beryllium Dr. Dunning Demonstrates the Splitting of the U-235 Uranium Atom, on the Face of a Cathode-Ray Tube.

Photograph courtesy North American Philips Co. and cut, Steel Magazine

the tremendous release of energy, and it was determined this was U 235 which comprises about 0.7 per cent of uranium proper. How to get sufficient quantities of this material was then the seemingly insurmountable problem which was solved by the gigantic plant at Oak Ridge and other developments throughout the country.

Professor Dunning gave a brief description of the tremendous installation at Oak Ridge, pointing out that there was probably about 120,000 miles of welding involved; almost 10,000 measuring and recording instruments were necessary, etc. This plant uses the gas diffusion process and it is so well designed that personnel is kept to a very minimum.

The speaker stressed the fact that U 235 is the stepping stone for all future fission reaction and studies.

Dr. Dunning devoted the closing portion of his address to discussion of possible future uses of nuclear energy and some of the economics, that is, how would the cost compare with other types of energy resulting from combustion of coal, fuel oils, gasoline, etc. While no conclusive statements were made it was evident that he and his associates are optimistic about the possibilities, but he did carefully circumscribe his tables of data by pointing out that in comparison with coal, for example, the cost of coal is only a portion of the total involved in getting energy to the consumer.

Pittsburgh District Sponsors Rubber Meeting

About 175 people attended the meeting sponsored by the Pittsburgh District on December 2 at Mellon Institute Auditorium, despite cold weather and icy roads. The meeting featured addresses by Society President Arthur W. Carpenter, Manager of Testing Laboratories, The B. F. Goodrich Co., Akron, Ohio, on "Progress in Rubber," and by H. N. Stevens, Coordinator, Research Division, The B. F. Goodrich Co., Akron, Ohio, on "Testing Materials with the Atomic Bomb." Mr. Carpenter discussed the policy which should be followed in connection with American rubber as compared with natural rubber, gave a concise picture of the present status of the industry, with respect to both production and utility of the materials, and referred to some of the newer applications of these materials. He emphasized particularly improvements in quality of American-made rubbers which already have been realized, and the advantages resulting from the ability to modify their properties to meet specific problems.

Mr. Stevens was the only observer from the rubber industry present at the atomic bomb tests near Bikini Atoll this summer, as a member of a group of civilian scientists witnessing the tests and reporting their findings to the Government. The colored film of the bomb explosions which augmented his talk, along with other illustrations made this address most interesting.

Both papers were well received and thought-provoking.

Executive Secretary C. L. Warwick also spoke at the meeting, giving a concise picture of more recent developments in phases of the Society's work.

President Carpenter Speaks at Chicago Meeting

The Chicago District played host to President Arthur W. Carpenter and Executive Secretary C. L. Warwick, Tuesday, January 7, 1947. An excellent dinner was served by the Merchandise Mart as the first part of this meeting and many new and old members of the Chicago District Council spent an interesting time meeting with the officers and renewing acquaintances.

Immediately following the dinner, the group adjourned to the auditorium of the Engineering Building at 205 W. Wacker Drive. A joint meeting was held with the Western Society of Engineers, Chemical and Metallurgical section, to hear a report by President Carpenter on the subject "Progress in Rubber." Mr. Carpenter, who is Manager of Testing Laboratories, The B. F. Goodrich Co. Akron, Ohio, and also served during the war in the Conservation Division of WPB, presented an interesting and concise report on rubber. He discussed the policy which should be pursued in connection with American or synthetic rubber. He very specifically pointed out that improvement in techniques and added knowledge obtained during the war made the synthetic or American-made rubbers an equal of crude rubber compounds in many respects, and very often made them superior to the old rubber products. He made a very special plea for the production of synthetic rubber, even though a very large amount of cheaper, natural rubber would become available in the future. This talk constituted a very comprehensive story of the relative position of rubber and synthetic rubber in the industrial field at the present time, and the trend for the future.

Joining Mr. Carpenter in the program was Mr. H. N. Stevens, Coordinator, Research Division, The B. F. Goodrich Co., Akron, Ohio, who presented motion pictures showing atomic bomb demonstrations off Bikini Island last summer. Mr. Stevens was a member of a group of civilian scientists witnessing the test and reporting the findings to the government. Mr. Stevens supplemented these pictures with an educational talk on the effects of bombs on various materials utilized in this important test.

Mr. Warwick spoke at the meeting outlining some of the more important current activities in A.S.T.M. work in reviewing the publication program, particularly the 7000-page 1946 Book of Standards. In referring to technical activities he commented on work which had been started in such fields as building construction and assemblies, fatigue testing, quality control of ma-

terials, etc. He referred to new work ahead including appearance standards and requirements for ultimate consumer goods and also noted some of the broad policy problems confronting the Society, for example, policies in connection with international standards work. He referred to the fact that the 1948 Annual Meeting and Exhibit are scheduled for Detroit in June with the Spring Meeting that year in Washington in March.

As evidence of the interest in the evening's program, a fine crowd of upwards of 250 was on hand to greet the two speakers. It was the definite consensus of Council members that President Carpenter had added to the store of current technical information at a most successful meeting. J. F. CALEF

D. L. Colwell, Chairman of the Chicago program committee, and Chicago representative of the National Smelting Company, planned the meeting and aiding him in carrying through were Chicago district officers, Chairman J. J. Kanter, the Crane Co., J. de N. Macomb, Vice-Chairman, Inland Steel Co., and Secretary G. E. Stryker, Bell & Howell Co.

Research Work on Electrical Heating, Resistance and Related Alloys

SOME 85 members and guests attended the 3-day meeting of Committee B-4 and its subcommittees held at Haddon Hall, Atlantic City, October 30, 31, and November 1. The meeting was characterized by reports of progress in many lines of cooperative research work which is the necessary prerequisite to the writing of methods of test and standards.

The Subcommittee on Wrought and Cast Alloys for High-Temperature Use is currently studying proposed revisions in the Tentative Specification for Nickel-Chromium-Iron Alloy Castings (35-12 Class) for High-Temperature Service (B 207 – 46 T) and expects to add another class, the 38-12.

The Subcommittee on Thermostat Metals is studying the construction of equipment to be used in connection with the Tentative Method of Test for Equivalent Yield Stress of Thermostat Metals (B 191 – 44 T) and is running cooperative tests on designs developed by committee members. The subcommittee is also studying the effect of temperature on the modulus of elasticity, and the effect of load *versus* thickness on Vickers hardness of thermostat metals.

Currently the most active work in the committee is that being carried on by the Subcommittee on Metallic Materials for Radio Tubes and Incandescent Lamps. As previously reported in the BULLETIN, the Section on Cathode Materials is carrying on extensive cooperative tests on the emissivity of cathode nickel. Of special interest at the present time is the study of 25 special melts of metal by means of which it is hoped to isolate the effect of variables in composition. The Diode, Data, Chemical, and Metallurgical Subsections all reported progress, and a fifth Subsection on Physical Testing has just been organized to review the Method of Testing Sleeves and Tubing for Radio Tube Cathodes (B 128 – 42), having in mind possible revision.

Another section of this subcommittee is actively studying the problem of particle size determination, and a new section has been organized which is working on a draft of a proposed method for measuring stress in metal-to-glass seals.

The Subcommittee on Methods of Test for Alloys in Controlled Atmospheres has actively taken up the study of "green rot," particularly its manifestation in the alloy of 90 per cent nickel-10 per cent chromium. Work in this subcommittee was interrupted by war activities but has now been resumed with full participation by the subcommittee members.

The Subcommittee on Contact Materials is cooperating in life tests on contact materials, and new data are being accumulated by the subcommittee members and are under review. The printing of the 1946 Supplement to the Bibliography on Electrical Contacts will be started soon and should be available within the next few months.

Henry Wysor New Steel Committee Secretary

COMMITTEE A-1 on Steel is pleased to announce the acceptance by Henry Wysor, Metallurgical Engineer, Bethlehem Steel Co., Inc., of appointment as Acting Secretary of this large Society group. The appointment became effective January 3, 1947, looking toward his election as permanent secretary at a meeting of the committee. The secretarial functions of this committee have been carried out for many years under a plan whereby a member of the Society's staff was assigned to act as staff assistant to aid in the secretarial work with an elected secretary, the expenses of this activity being underwritten by the committee. For a number of years R. J. Painter of the A.S.T.M. Staff served in this capacity and for the past two years Mr. Painter has served as Secretary. The Board of Directors of the Society believe that the committee should have a secretary in industry, rather than look to Headquarters to supply the secretary, but it is prepared to give stenographic help.

Committee A-1 has just completed a most active year, revising a large number of its specifications and promulgating a number of new and consolidated specifications, particularly those covering plates, both for pressure vessel and structural applications. There is much current activity in several of the subcommittees, notably in Subcommittee XV on Bar Steels, and in Subcommittee XI on Steel for Pressure Vessels. A new subcommittee is now in the process of organization on bolting for service at normal temperatures, this group to be headed by Arthur D. Morris, President, Bayonne Bolt Corp. This subcommittee will have its organization meeting within the next few weeks.

Highway and Construction Material Committees Meet in Washington

A GROUP of A.S.T.M. technical committees held meetings in Washington, D. C., during the week of December 1, 1946, whose membership represent some of the best technical and research authorities in the country in the field of cement, concrete, and highway engineering materials. The twenty-sixth annual meeting of the Highway Research Board provided a good setting for this group of meetings and influenced the resulting good attendance at the meetings.

Committee C-1 on Cement held a general meeting during the morning of December 3, presided over by Chairman F. H. Jackson, and preceded by an Advisory and several subcommittee meetings on the previous day. Through the courtesy of the Public Roads Administration, the facilities of the Division of Physical Research were made available for the meeting.

Among the administrative matters presented was the announcement of the formation of a new working committee on methods of test for air entrainment.

In the reports of the various sponsoring and working subcommittees several items of interest were noted. The report of the Sponsoring Committee on Portland Cement was accepted noting changes being considered in the chemical requirements of the specifications for portland cement (C 150) and air-entraining cement (C 175). These changes, when adopted, will effect closer agreement between the Federal and the A.S.T.M. specifications. Improvements in the design details of the Burmister flow trough were accepted for reference to letter ballot. The project of an adequate workability test was recommended for presentation to the Portland Cement Association for attention. The Sponsoring Committee on Masonry Cement reported that plans had been made for an extensive series of tests preparatory to the formulation of a durability specification for masonry cement.

The current assembling of results of long-term tests was announced by the Working Committee on Volume Change and Soundness. A new series of cooperative tests on time of set will be instituted by the committee concerned based on the summary of the previous study. A comprehensive report was submitted and distributed by the Working Committee on Bleeding, Plasticity and Workability, giving results of recent studies. The Working Committee on Methods of Chemical Analysis proposed revisions in details of methods C 114 and C 114 T, including additions to the tentative alternate determination of sodium oxide and potassium oxide to strengthen the warning against the danger of explosion when organic matter is contained in the cement. The proposals were approved by C-1. An extensive cooperative study will be inaugurated by a group of laboratories sponsored by the Working Committee on SO_3 Content, involving the relationship between properties; reproducibility; effect on durability, and effect of time on set.

The members present approved the proposal that the spring meeting of Committee C-1 be coordinated with that of Committees C-9 and D-4, in Cincinnati.

Committee C-9 on Concrete and Concrete Aggregates met in general session during the afternoon of December 3, using the same facilities as that of Committee C-1 and under the direction of Chairman K. B. Woods. The Advisory and other subcommittees held meetings on December 2. The reorganization plan, which embodies the feature of combining subcommittees under administrative, research, and test methods and specification groups, was submitted as the principal administrative item. Approval was given for the distribution of the latest draft of the plan to the membership for comments.

Some of the high points of interest in the several subcommittee reports are mentioned here. A revision of the term "admixture" was discussed and the Editorial Subcommittee was instructed to make further study on this term with correlation being made with Committee C-1 inasmuch as the term covers a material used by both Committee C-1 and C-9 interests. A bibliography of articles on chemical reactions in concrete has been prepared jointly by the Subcommittee on Chemical Reactions and the Indiana State Highway Research Project at Purdue University. The fundamentals influencing present freezing and thawing test methods are being scrutinized by the Subcommittee on Methods of Tests. Progress is being made on two proposed tentatives covering method of evaluation of air-entraining admixtures for concrete and a method of test for bleeding of concrete containing admixtures. Further changes are being considered in the revision of the soundness test for aggregates (C 88) to correct existing objectionable features pertaining to the drying period and the length of cycle. Approval was given to the recommendation that the proposed revision of the Specifications for Ready-Mixed Concrete (C 94) be revised to provide for the use of nonagitating equipment for transporting concrete. Details of limitations on types of concrete, length of haul, etc., for such transportation, are yet to be worked out. The next meeting of Committee C-9 will be held during the latter part of March, 1947, a place yet to be selected, in coordination with meetings of Committees C-1, D-4 and D-18.

The Advisory Subcommittees of Committees C-1 and C-9 met jointly at a dinner meeting held at the Hotel Statler on December 2. This was the first of a series of such meetings to be held annually. It is felt that the allied interests of these two committees will justify the need for these annual joint sessions, thus expediting the work of both committees.

Three items received attention and action. The problem of developing test data and research concerning the chemical reactivity in portland-cement concrete will be handled by a division of the work into two phases between the committees. A procedure to guide the engineer by means of some standard test method will be studied by the Subcommittee on Volume Change and Soundness of Portland

Cement of Committee C-1, and the long-time research on this subject will be undertaken by the Subcommittee on Chemical Reactions of Aggregates in Concrete of Committee C-9. Both subcommittees will be augmented by representatives from the other technical committee. Needed correlation between the two committees on the definition of the term "admixture" was discussed. A recommendation was made that the matter be referred back to the proper subcommittees of each committee for the necessary correlation. The expansion of the work of the Cement Reference Laboratory, now under Committee C-1, to include the inspection and checking of compression machines up to 200,000-lb. capacity, received considerable discussion. This proposed expansion would now become of joint interest to both committees. General agreement was reached on the desirability of this expansion and the formation of a joint subcommittee to study the problem of the proper ways and means of underwriting such a project was approved.

The Advisory Subcommittee of *Committee D-4 on Road and Paving Materials* met at the National Crushed Stone Association laboratories during the morning of December 4. This was the first opportunity for the new officers, Chairman W. J. Emmons of the University of Michigan, and Secretary B. A. Anderton of the Barrett Division, Allied Chemical and Dye Corp., to meet with the advisory group. Considerable attention was given to membership and administrative matters. The need for a study of the entire subcommittee structure and balanced representation was expressed. The Vice-Chairman in charge of each group of subcommittees will give this matter special study. Each subcommittee will also be asked to submit a progress report to its respective group vice-chairman before the next meeting of Committee D-4. The next meeting of Committee D-4 will be held in conjunction with meetings of Committees C-1 and C-9 during the last week of March in Cincinnati.

The Advisory Subcommittee of *Committee D-18 on Soils for Engineering Purposes* gathered at the National Academy of Sciences during the evening of December 4 for a very intensive and productive meeting. All members were present with Chairman E. J. Kilcawley presiding. Very favorable progress was reported on the plans for the Symposium on Shear and for the session on other technical papers covering soils engineering to be given at the 1947 Annual Meeting of the Society. The latest draft of the plan for reorganization of the committee was discussed and adopted after certain changes and will be referred to the entire committee preparatory to official adoption at the next committee meeting. The spring meeting of Committee D-18 will be held in connection with the meetings of Committees C-1, C-9, and D-4 in Cincinnati during the last week in March.

Joint Subcommittee on Tests and Specifications for Stabilized Soils of Committees D-4 and D-18 met during the evening of December 4 at the National Academy of Sciences, presided over by Chairman H. F. Clemmer. A very well-attended and responsive meeting resulted with definite progress being made on the main item of business, namely the proposed Method of Test for the Determination of Absorption, Expansion, and Strength Characteristics of Soil-Bituminous Mixtures developed by the Bituminous Producers Cooperative Research Committee. Discussion centered around the use of the terms "strength," "stability," and "extrusion" as a measure of the test results, and the treatment of cured *versus* uncured specimens. Agreement was reached on the substance of certain changes in the terminology of the method and the phrasing of the scope in particular which would be acceptable to the entire group. These revisions will be circulated to the entire subcommittee when completed by the responsible section.

To the A.S.T.M. Committee on Membership, 1916 Race St., Philadelphia 3, Pa.

Gentlemen:

Please send information on membership to the company or individual indicated below.

_____

_____

This company *(or individual)* is interested in the following subjects: *(indicate field of activity, that is, petroleum, steel, non-ferrous, etc., etc.)*

_____

*(Signed)*_____

Date_____ Address_____

Revisions in Marking Structural Clay Tile

ADVICE has just been received from A.S.T.M. Committee C-15 on Manufactured Masonry Units of a change the committee is considering making in the requirements for marking structural clay tile as given in Section 7 of the standard specifications covering Structural Clay Load-Bearing Wall Tile (C 34–41), Structural Clay Non-Load-Bearing Tile (C 56–41), and Structural Clay Floor Tile (C 57–39).

A tentative revision of Section 7 on "Marking" in each of the above specifications was accepted by the Administrative Committee on Standards on September 9, 1946, and is published in Part II of the 1946 Book of A.S.T.M. Standards. Instead of the revision as it appears in the Book of Standards, Committee C-15 is recommending that the revision in Specifications C 34, C 56, and C 57 should read as follows:

Section 7.—Change to read as follows: "At least 80 per cent of each shipment of structural clay tile, as delivered to the site, shall bear the name, initials, trademark, or identification of the manufacturer. These marks shall be indented on the outside or inside of the tile and shall be easily identified."

Committee C-15 has requested publication of the above recommendation for comment or criticism, which should be directed to A.S.T.M. Headquarters.

Analysis of Metals; Correction in Brass Methods

AT A local meeting of members of Division B on Non-Ferrous Metals, of A.S.T.M. Committee E-3 on Chemical Analysis of Metals, held in Newark, N. J., on December 11, 1946, it was announced that a new method for Determination of Small Amounts of Aluminum by 8-Hydroxyquinoline (Colorimetric) Method is being cooperatively tested and will probably be submitted to the Society for publication as tentative during 1947.

Also being cooperatively tested prior to submittal for publication as tentative are Methods for the Chemical Analysis of Copper-Nickel-Zinc and Copper-Nickel Alloys which include procedures for copper, lead, tin, zinc, nickel, cobalt, manganese, and iron. These methods will fill the need for procedures for the chemical analysis of high-nickel copper-base alloys.

An editorial correction was approved in the Tentative Methods of Chemical Analysis of Special Brasses and Bronzes (E 54 – 46 T). The limits on iron content given in Section 1 (*a*) of Methods E 54 were revised from "0.0 to 4 per cent" to read "0.0 to 5 per cent" so that these methods will be applicable to iron contents up to 5 per cent as covered in the A.S.T.M. Tentative Specification for Aluminum-Bronze Sand Castings (B 148 – 46 T). The desirability of this correction became apparent as a result of a complete survey of the requirements on chemical analysis which are incorporated in the specifications developed by Committee B-5 on Copper and Copper Alloys. It was agreed that the intent in setting the limit on iron content in Methods E 54 was to cover the range of iron content included in A.S.T.M. specifications for materials classed as special brasses and bronzes, and that the procedure in Methods E 54 has been shown to be fully satisfactory for iron contents as high as 5 per cent.

Excerpt from a Letter Transmitting a Contribution to the A.S.T.M. Building Fund

THIS excerpt came from a long-time railroad man affiliated with the Society since 1902: "I joined the Society with high hopes of being able to take an active part in the work it set out to do, but the circumstances of my employment made such participation more and more impossible as time went on. In spite of this, I have always indulged myself in a certain pride in being connected with the inception of an organization which has been effective in establishing harmonious relations, and highly constructive cooperation, between producers and users of engineering materials at a high level, with marked benefit to both. To one conversant with conditions in this respect at the beginning of the century, this is a real achievement, and well worth all the unselfish effort which has gone into it."

To the A.S.T.M. Committee on Membership

1916 Race St., Philadelphia 3, Pa.

Gentlemen:

Please send me information on membership in A.S.T.M. and include a membership application blank.

*(Signed)*_____

Address_____

Date_____

_____

Oils for Rubber Tests

Two of the standard petroleum base oils to be used in connection with A.S.T.M. tentative methods D 471–46 T have recently become available through the cooperation of two companies in the petroleum field. These oils designated No. 1, low swelling, aniline point 124 C and No. 3, high swelling aniline point 70 C, have been cross checked in a cooperative program among several laboratories and each oil has been found to be within the required tolerance of plus or minus 1.8 F. on aniline point.

The Methods D 471 entitled Tentative Methods of Test for Changes in Properties of Rubber and Rubber-Like Materials in Liquids, developed by A.S.T.M. Committee D-11 on Rubber Products indicate that for purpose of test it is usually desirable to use the liquid with which the material to be tested will come into contact in service. For comparative tests with liquids of unknown or doubtful composition, samples of liquid from the same drum or shipment shall be used. Many commercial liquids, particularly petroleum products, are subject to sufficient variation that it is not practical to use them for test media. It is then advisable to substitute standard test media covering the range of properties that may be encountered in the particular liquid.

The two organizations which have cooperated to make the petroleum based oils are Stanco Distributors, Inc., and Sun Oil Co.

A.S.T.M. Oil No. 1 may be ordered as such from Stanco Distributors, Inc., Chemical Products Dept., attention Mr. A. B. Boehm, 26 Broadway, New York 4, N. Y.

A.S.T.M. Oil No. 3 may be ordered as such from the Sun Oil Co., attention Dr. J. B. Hill, Marcus Hook, Pa.

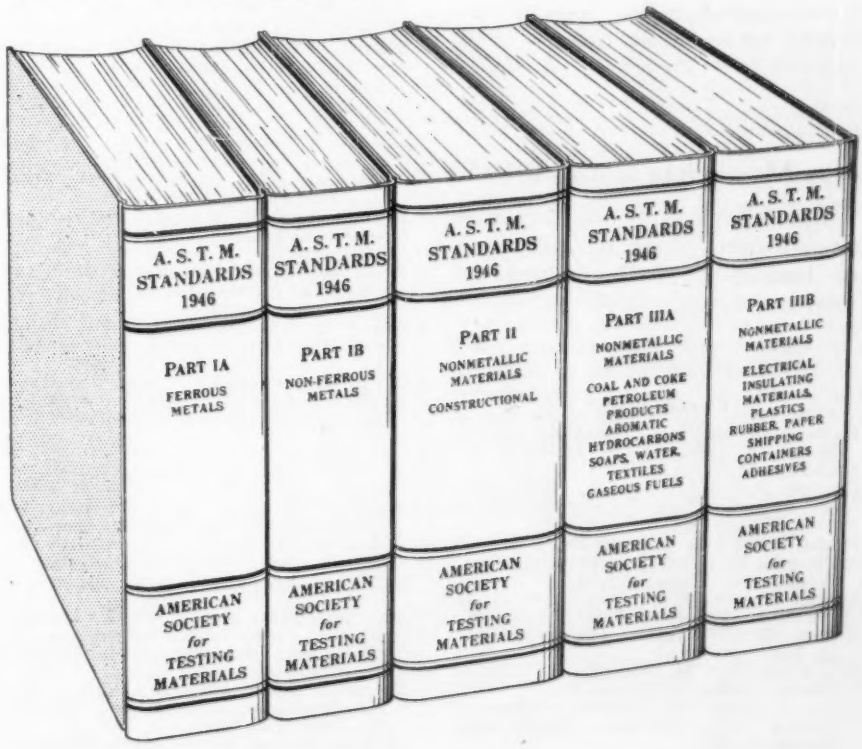
In five-gallon lots, each of the oils can be procured at $1.15 per gallon but the price for a drum of fifty-five gallons is $1 per gallon.

Schedule of A.S.T.M. Meetings

Date	Group	Place
February 24–28	Spring Meeting and Committee Week	Philadelphia, Pa.
March 3, 4, 5	D-20 on Plastics	Cincinnati, Ohio
March 4	New York District	New York, N. Y.
March 10	Northern California District	San Francisco, Calif.
March 12, 13, 14	D-13 on Textiles	New York, N. Y.
March 13	Western New York-Ontario District	Rochester, N. Y.
March 18	Southern California District	Los Angeles, Calif.
March 25	Philadelphia District	Philadelphia, Pa.
March 26–28	Committees C-1, C-9 D-4, D-18	Cincinnati, Ohio
April 10, 11	Committee D-10 on Shipping Containers	Philadelphia, Pa.
June 16–20	50th Annual Meeting	Atlantic City, N. J.

Error in Specifications for Stranded Copper Conductors

Attention of the membership is called to a typographical error in the Standard Specifications for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft (B 8 – 46) as published in Part I-B of the 1946 Book of A.S.T.M. Standards. In Table I of the specifications the requirement of "50 ft." for the minimum distance between joints in the completed conductor for Class AA for 19 strand conductors dropped out in this printing. Those who receive Part I-B of the Book of Standards will wish to correct their copy of Specifications B 8 by inserting "50 ft." in the second column of Table I which appears on p. 49 of the book.



1946 Book of A. S. T. M. Standards—Nearing Completion, 1400 Standards; 7000 Pages.

Division of Mineral Products of National Bureau of Standards

THE November issue of the *Technical News Bulletin*, National Bureau of Standards, announces that, effective September 24, the former Division of Clay and Silicate Products was designated the Division of Mineral Products. The work of this Division, IX as heretofore, is confined to nonmetallic mineral products.

At the same time a new section on Constitution and Microstructure was established, with Dr. Herbert Insley as chief. This section comprises two laboratories: (1) The Laboratory of Microscopic and Diffraction Analysis, the purpose of which is the development of technique and methods of analysis of mineral products by X-ray and electron diffraction; H. F. McMurdie is in charge of this laboratory; and (2) the Crystal Synthesis Laboratory, which will study constitution, synthesis, and phase relations at high temperatures, under Dr. Insley.

Certain changes in the names of the sections were also made, so that Division IX now consists of the following sections: 1. Porcelain and Pottery; 2. Glass; 3. Refractories; 4. Enameled Metals; 5. Constitution and Microstructure; 6. Concreting Materials; 7. Masonry and Reinforced Concrete; 8. Lime and Gypsum; 9. Building Stone.

Many of the men in this Division are active in the Society, and Past-President P. H. Bates was for many years Chief of the Division of Clay and Silicate Products.

Optical Glass:

This same issue of the Bureau's *News Bulletin* has an interesting article on the Research and Production of Optical Glass at the Bureau. Very important contributions, not only from the standpoint of testing and research, were contributed by the Bureau in connection with optical glass used in World Wars I and II but the experimental glass plant there was greatly expanded in both wars to produce extremely high-quality glass so essential in many optical uses.

Catalogs and Literature Received

BURRELL TECHNICAL SUPPLY CO., 1936–42 Fifth Ave., Pittsburgh 19, Pa. An interesting 12-page folder, 8½ by 11 in., profusely illustrated, describes the Turner-Burrell Adsorption Fractionator, first displayed in the A.S.T.M. Exhibit in Buffalo in June, 1946. Folder describes this instrument which is designed for the analysis of gas mixtures containing light hydrocarbons. The booklet notes some of the highlights of the machine, discusses adsorption fractionation; the principal parts of the equipment are detailed, and there is description on various operations and procedures used.

EASTMAN KODAK CO., Industrial Sales Division, Rochester 4, N. Y. A new, four-page folder describing Kodak Transfax, a reproduction process for use with metals, plastics, and plywood or pressed woods. The booklet explains briefly the steps in using the light-sensitive Transfax solution for transferring working diagrams, legends, designs, or other line work from a drawing to fabricating materials.

Also, a four-page folder describing Kodatrace, a new translucent tracing material, developed to provide clean, easy-to-read engineering prints. The material is made of safety-base film tinted blue with a fine-grained matte surface suitable for use with pencil or ink.

GEORGE SCHERR CO., INC., 200 Lafayette St., New York 12, N. Y. The new 1947 Scherr Tool Catalog, 96 pages. The new catalog is divided into groupings some of which are as follows: laboratory instruments (metallurgical equipment, gas and electric furnaces, microscopes); machine tools such as toolroom, vertical and horizontal milling machines; machinists' tools (micrometers, stainless steel vernier calipers, sine bars, etc.); measuring instruments such as comparators, gage and angle blocks, gear testers, height gages, and many other new measuring tools; optical equipment; toolroom specialties such as magnetic chucks, grinding attachments and magnetic holding devices. Also, there is a section on transmission equipment and gears, couplings, chains, speed reducers, etc. In addition to illustrations, specifications and descriptions of above equipment, the catalog devotes space to examples of the type of work that can be handled with some of these instruments and tools.

THE EMIL GREINER CO., 161 Sixth Ave., New York 13, N. Y. A four-page folder entitled "How to Make Standard Volumetric Solutions in a Few Minutes"—illustrated. Price list and quantity discounts are given.

Also, a four-page folder covering "Accutint—for Quick, Dependable pH Measurement." Illustrated.

News of Instrument Companies

A NOTE in *Business Week* indicates that five leading laboratory supply and instrument dealers and manufacturers have formed what is termed the United States Scientific Export Assn., Inc. The companies participating include the following: Fisher Scientific Co. of Pittsburgh, Eimer & Amend of New York, and Chicago Apparatus Co., W. M. Welch Mfg. Co., and E. H. Sargent & Co., all of Chicago. The article further points out that the association under the Webb-Pomerene Export Trade Act would be exempt from any antitrust actions so long as there is no restraint of trade.

The new 20,000,000-volt Betatron, built by Allis-Chalmers Manufacturing Co., was unveiled to a group of Engineers and other technical people, at the Picatinny Army Arsenal, New Jersey, on November 18. There was a technical discussion at the meeting by representatives of the manufacturers together with a demonstration.

New Members to January 2, 1947

The following 88 members were elected from December 16, 1946, to January 2, 1947, making the total membership 6186.

Names are arranged alphabetically—company members first, then individuals.

Chicago District

BASSIN, CHESKIN & TOKARSKY, Arthur Bassin, Partner, 407 S. Dearborn St., Chicago 5, Ill.

CHICAGO HYDRAULIC OIL CO., Burton Paxton, Secretary-Treasurer, 11618 S. Front Ave., Chicago 28, Ill.

JEWEL PAINT AND VARNISH CO., James E. Creager, Technical Director, 345 North Western Ave., Chicago 12, Ill.

SINGER MANUFACTURING CO., THE, H. R. Ohlheiser, Superintendent, Engineering Dept., 2115 W. Western Ave., South Bend 21, Ind.

BLACKMAR, DON H., Metallurgist, Modine Manufacturing Co., Racine, Wis.

CARROLL, JOHN W., Supervisor, Physical Testing Lab., Reynolds Metals Co., Brookfield, Ill.

JOHNSTONE, W. W., Chemical Engineer Universal Oil Products Co., 310 S. Michigan Ave., Chicago 4, Ill.

KANHOFER, E. R., Assistant Manager, Universal Oil Products Co., P. O. Drawer C, Riverside, Ill.

MORIARTY, F. C., Department Head, Universal Oil Products Co., 310 S. Michigan Ave., Chicago 4, Ill.

WARNER, WALFRID, Metallurgist, Inland Steel Co., 38 S. Dearborn St., Chicago 3, Ill.

WASHBURN, THOMAS S., Assistant Manager, Metallurgical and Inspection Dept., Inland Steel Co., 38 S. Dearborn St., Chicago 3, Ill.

Cleveland District

KETTERS, KARL L., Special Metallurgical Engineer, The Youngstown Sheet and Tube Co., Youngstown 1, Ohio.

Detroit District

DURBIN, CARL O., Materials Engineer, Chrysler Corp., 12800 Oakland Ave., Detroit, Mich. For mail: Route 1, Walled Lake, Mich.

KELLER, PAUL J., Head of Analytical Lab., Rinshed-Mason Co., 5935–71 Milford St., Detroit 10, Mich.

MCLAIN, STUART, Head, Chemical Engineering Dept., Wayne University, 5140 Second Ave., Detroit 1, Mich.

New England District

RESPRO, INC., Albert J. Hanley, Technical Director, Wellington Ave., Cranston 10, R. I.

BONINO, HUGH J., President, Atlantic Chemical Co., Inc., Centredale, R. I.

BUCK, ROBINSON D., Partner, Buck & Buck, 650 Main St., Hartford 3, Conn.

TULLOCK, DANIEL A., JR., Metallurgist, The Holo-Krome Screw Corp., Hartford 10, Conn.

New York District

DU COURT MILLS, INC., Raymond Palmer, Chemist, 77 White St., New York 13, N. Y.

LANE AND CO., INC., J. H., William S. Baxter, Secretary and Treasurer, Box 82, Station G, New York 19, N. Y.

CARTER, L. L., Assistant Chief Engineer, Anaconda Wire and Cable Co., Hastings-on-Hudson 6, N. Y.

CLEMENS, MAX, Tool Designer, Eisen Metal Products Co., 175 Main St., Lodi, N. J., For mail: 346 E. Forty-ninth St., New York 17, N. Y.

EATON, FREDERIK S., Director, Research and Design Inst., Inc., 115 E. Fortieth St., New York 16, N. Y.

FAIRCHILD, CHARLES OWEN, Consulting Engineer, 114-74 178th Place, St. Albans 12, N. Y.

GOODLOE, PAUL M., Brown Co., 500 Fifth Ave., New York 18, N. Y.

GWYN, CHILDRESS B., JR., Chief Engineer and General Manager, Tungsten and Sintered Metals Division, The H. A. Wilson Co., 105 Chestnut St., Newark 5, N. J. For mail: 21 N. Glen Rd., Mountain Lakes, N. J.

HARDY, CHARLES J., Metallurgical Engineer, Charles Hardy, Inc., 420 Lexington Ave., New York 17, N. Y. [J]*

HEDGER, F. H., Charles Pfizer and Co., Inc., 11 Bartlett St., Brooklyn 6, N. Y.

KINNAIRD, ROBERT N., JR., Chemist, Socony-Vacuum Laboratories, 412 Greenpoint Ave., Brooklyn 22, N. Y.

LANGSAM, MARTIN, Chemical Engineer, Drice Industrial Corp., 559 W. Thirty-fifth St., New York, N. Y. For mail: 1554 Ocean Ave., Brooklyn, N. Y. [J]

LAWSON, W. L., Vice-President, Whitehouse Products, Inc., 360 Furman St., Brooklyn 2, N. Y.

NICHOLL, J. F., Manager, Upholstery Fabric Section, Lumite Division, Chicopee Manufacturing Corp. of Georgia, 47 Worth St., New York 13, N. Y. For mail: 179 Summit Ave., Upper Montclair, N. J.

SCHACHTER, MYRON MARVIN, 91 E. Eighteenth St., Brooklyn 26, N. Y. [J]

STRUBHAR, PAUL D. Chief Metallurgist, Remington Rand, Inc., Wilson Ave., S. Norwalk, Conn.

TESI, A. FRANK, Staff Engineer, American Standards Assn., 70 E. Forty-fifth St., New York, N. Y. For mail: 60 Smith Ave., Bergenfield, N. J.

WESTBYE, J. B., Electrical Engineer, Gibbs & Hill, Inc., Pennsylvania Station, New York 1, N. Y.

Northern California District

SMITH, FRANK C., Metallurgical Engineer, Bethlehem Pacific Coast Steel Corp., Twentieth and Illinois Sts., San Francisco, Calif.

SPRAGUE, WILLIAM E., Junior Engineer, Sprague Chemical, Box 817, Quincy, Calif. [J]

Philadelphia District

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I-T-E CIRCUIT BREAKER CO., W. H. Edmunds, Engineer, Nineteenth and Hamilton Sts., Philadelphia, Pa.

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KELLY, JOHN P., President, John P. Kelly, Inc., Twenty-third and Westmoreland Sts., Philadelphia 40, Pa.

RAMAN, PETER P., Chief Chemist, John B. Stetson Co., Fifth St. and Montgomery Ave., Philadelphia, Pa.

SCHARFENBERG, C. A., Executive Engineer, Mack Manufacturing Corp., Allentown, Pa.

Pittsburgh District

BURGER, ELMER B., Assistant Chemist in Charge, Carnegie-Illinois Steel Corp., Homestead Steel Works, Munhall, Pa. For mail: 118 Kilmer St., Pittsburgh 21, Pa.

BURKHALTER, C. A., Manager, Standards and Practices Division, Wheeling Steel Corp., Wheeling Steel Bldg., Wheeling, W. Va.

DOWNES, DANIEL T., Senior Mechanical Glass Research Engineer, Pittsburgh Plate Glass Co., Creighton, Pa. For mail: 462 Biddle Ave., Pittsburgh 21, Pa.

FREY, ALBERT A., Special Metallurgist, Wheeling Steel Corp. Wheeling Steel Bldg., Wheeling, W. Va.

SEEGER, L. W., JR., National Tube Co., McKeesport, Pa.

SIMONIN, JOSEPH E., Metallurgist, Pittsburgh Steel Co., Allenport, Pa.

St. Louis District

SMITH, BARCLAY F., Chemist, Carter Carburetor Corp., 2840 N. Spring, St. Louis 7, Mo.

Southern California District

BROADSTON, JAMES A., Armament Design Engineer, North American Aviation, Inc., Municipal Airport, Los Angeles 45, Calif.; and Chief Engineer, Surface Checking Gage Co., Hollywood 28, Calif. For mail: 1937 Taft Ave., Hollywood 28, Calif.

Western New York and Ontario District

DALGISH CHEMICALS, LTD., A. W. Miller, Chief Chemist, 140 Liberty St., Toronto, Ont., Canada.

LIGHTNING FASTENER CO., LTD., F. C. Rutherford, Chemical Engineer, 50 Niagara St., St. Catharines, Ont., Canada.

GRIFFENHAGEN, R. P., Manager, Materials and Process Section, Westinghouse Electric Corp., Motor Division, Buffalo 5, N. Y.

MILLER, EDWARD A., Chief Engineer, Building Panel Div., Detroit Steel Products Co., 1210 E. Ferry St., Buffalo 11, N. Y.

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RUBEROID CO., THE, Miles V. Engelbach, Manager, Field Engineering, 6903 Brookeville Rd., Chevy Chase 15, Md.

UNION WIRE ROPE CORP., W. Voigtlander, Technical Director, Twenty-first and Manchester, Kansas City 3, Mo.

AINES, ANDREW A., Industrial Engineer, Products Testing Div., The Quartermaster Board, Camp Lee, Va.

BATEMAN, C. H., Metallurgical Engineer, Tennessee Coal, Iron and Railroad Co., Birmingham, Ala. For mail: Fairfield Tin Mill, Fairfield, Ala.

BROSNAN, D. W., Chief Engineer, Maintenance, Way and Structure, Southern Railway System, 307 E. Fourth St., Cincinnati 2, Ohio.

COLLINS, W. D., Box 284, Benjamin Franklin Station, Washington 9, D. C.

DEAUX, RICHARD E., Process Engineer, Gibson Refrigerator Co., Greenville, Mich. For mail: 419 W. Cass St., Greenville, Mich.

EBERHARDT, FRANK C., Assistant Engineer, Morrison-Knudsen Co., Inc., Kortes Dam Project, Box 440, Casper, Wyo. [J]

EISENBERG, AARON A., President and Works Manager, Southern Lacquer Co., 1426 Philpot St., Baltimore, Md. For mail: 3723 Towanda Ave., Baltimore, Md.

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MARSH, JOHN W., President, John W. Marsh Engineering Corp., 1404 Twenty-second St., South, Arlington, Va.

McMILLAN, CLAUDE RICHELIEU, JR., Instructor of Civil Engineering, University of South Carolina, Box 189, Columbia, S. C. [J]

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RAMBERG, WALTER, Physicist, National Bureau of Standards, Washington 25, D. C.

SNYDER, ERNEST B., Refractories Engineer, Wheeling Steel Corp., South Works, Steubenville, Ohio.

TRIMBLE, J. R., Assistant Manager, Department of Metallurgy, Inspection and Research, Tennessee Coal, Iron and Railroad Co., 1508 Brown-Marx Bldg., Birmingham 2, Ala.

U. S. NAVAL RESEARCH LABORATORY, Ruth H. Hook, Librarian, Washington 20, D. C.

WALLACE, ALEXANDER E., Research Engineer, M & R Dietetic Laboratories, Inc., 585 Cleveland Ave., Columbus, Ohio.

WILSON, JOHN H., II, Student, Route 8, Box 502, Fort Worth, Tex. [J]

Other than U. S. Possessions

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BRAUN, CARLOS JUAN, Technician, Pinturas Cerestia, Casilla 237, Santiago, Chile.

EVANS, ERIC B., Esso European Laboratories, Esso House, Abingdon, Berks, England.

JENKIN, JOHN WATSON, Director of Research, Research Dept., Tube Investments, Ltd., Wheelwright Rd., Erdington, Birmingham, England.

LOBSEIN, ANDREW, Technical Manager, Colorin S. A., Av. Velez Sarsfield 5853, Munre, F.F.C.C. Del Estado, Argentina.

PALM, JAN H., Chief Metallurgist, Nationaal Luchtvaartlaboratorium, Sloterweg 145, Amsterdam W, Netherlands.

WILLIAMS, R. K., City Chemist, City Engineer's Dept., Box 990, Salisbury, South Rhodesia, South Africa.

* [J]—Denotes Junior Member.

Personals . . .

. . .News items concerning the activities of our members will be welcomed for inclusion in this column.

FRANK M. CLARK, insulation expert at the Pittsfield Works of the General Electric Company's Apparatus Department, and Assistant Engineer of the Works Laboratory there, has been named Technical Consultant on Insulation of the entire Apparatus Department.

The November, 1946, S.A.E. *Journal* includes excerpts of an interesting paper by A.S.T.M. Vice-President T. A. BOYD, General Motors Research Laboratories Division, relating to the bouncing-pin indicator and its silver anniversary. Mr. Boyd points out that this device is still being used in the rating of automobile gasolines for octane number and is incorporated in the A.S.T.M. method and a number of others, and as modified is also used for rating Diesel fuels.

JOHN C. MOORE, Superintendent, Paint Plant, Sinclair Refining Co., Marcus Hook, Pa., and an active member of A.S.T.M. Committee D-1 on Paint, Varnish, and Related Materials was elected President of the Federation of Paint and Varnish Production Clubs at their recent annual meeting. CARLTON H. ROSE, Chemist, National Lead Co., Brooklyn, and Secretary of A.S.T.M. Committee D-1, was elected Vice-President of the same organization.

EDGAR W. JONES, formerly with the Chrysler Corp., is now Development Engineer, Bruce Products Corp., Detroit.

DR. JOHAN BJORKSTEN, owner of Bjorksten Laboratories, Chicago, announces that he is forming a corporation under the name of Bjorksten Research Laboratories. This corporation will continue and expand the business of Bjorksten Laboratories.

H. E. HALL, President of the Metals Disintegrating Company, Elizabeth, N. J., was reelected President of the Metal Powder Association at the recent annual meeting of this group; S. K. Wellman, President of S. K. Wellman Co., Cleveland, was reelected Vice-President; and F. E. Wormser, Secretary, Lead Industries Assn., New York, continues as Acting Secretary and Treasurer. P. E. Weingart, of the American Metal Company Ltd., New York, was elected Chairman of the Board of Directors, on which B. T. duPont, of the National Radiator Co., Johnstown, T. L. Robinson of S. K. Wellman Co., and W. M. Weil, of the National Smelting Co., Cleveland, also serve as members.

FREDERICK R. LACK, Vice-President of Western Electric Co., will be President of the American Standards Association for the ensuing year; Mr. Lack was formerly Vice-President of the association. George H. Taber, Jr., Executive Vice-President of the Philadelphia Electric Co., was elected Vice-President of the A.S.A. for the coming year. Mr. Taber is Alternate Representative for the American Institute of Mining and Metallurgical Engineers on Sectional Committee Z11 on Petroleum Products and Lubricants.

LAURISTON S. TAYLOR, Chief of the X-Ray Section, National Bureau of Standards, has been awarded the Medal of Freedom by the War Department, for exceptionally meritorious achievement during wartime. In recognition of his outstanding leadership, analytical ability, and technical skill in the prosecution of the war against the enemy in Continental Europe, he was awarded also the Bronze Star Medal. Mr. Taylor serves as a representative of the Bureau of Standards on A.S.T.M. Committee E-7 on Radiographic Testing.

GUY S. LA FORGE, A.S.T.M. member since 1913, retired on December 1 after a long career in the cement industry, during which he served as chemist and in other capacities in cement plants in various sections of the United States and in Ontario, Canada. He was with the Pearson Engineering Company during construction of the Medina Valley Dam at San Antonio, Texas, and the Tremp Dam at Barcelona, Spain. From 1918 until his retirement he had been Superintendent of the Lehigh Portland Cement Company's plant at Union Bridge, Md. During his administration, the Union Bridge plant achieved one of the outstanding safety records in the industry: a total of nine years without a lost time accident, five of those years being consecutive. Mr. La Forge has served for many years as an active member of A.S.T.M. Committee C-1 on Cement.

HENRY M. MARC, formerly with the Philip Carey Mfg. Co., is now Assistant General Manager of the C. J. Tagliabue Division of Portable Products Corp., Brooklyn.

B. P. MULCAHY, for the past 11 years Research Engineer for the Citizens Gas and Coke Utility of Indianapolis, has announced the opening of his own offices in Indianapolis as Engineering Consultant on Cupola Operation and Coal Carbonization. He plans to specialize in the field of foundry coke in cupola operation and the selection of coals in coal carbonization processes. His offices will be located at 3825 Arthington Blvd., Indianapolis 1, Indiana.

M. H. BIGELOW has returned from duty with the Chemical Warfare Service, U. S. War Dept., after extended service in the U. S. and Germany as Lieutenant Colonel, to resume duties as Director of Technical Service, Plaskon Division, Libbey-Owens-Ford Glass Co., Toledo, Ohio.

C. E. HOYT who recently retired as Treasurer of the American Foundrymen's Association, after affiliation with the association for 30 years in various capacities, has been honored by A.F.A. by the renaming of its foundation lecture the Charles Edgar Hoyt Annual Lecture. In announcing the renaming of the lectureship President Wood said of Mr. Hoyt, "he has played as large a part as any living man in the development of the foundry industry's appreciation of its technical progress potential." The action marked the second time A.F.A. has honored Mr. Hoyt: in 1941 it awarded him the Joseph S. Seaman gold medal and honorary membership for outstanding service to the industry.

R. H. HEDRICK, formerly Chemical Engineer, Gulf Research and Development Co., Pittsburgh, is now affiliated with the Department of Agricultural Chemistry, Purdue University, Lafayette, Ind.

R. H. EHRMANN is now Research Chemist and Patent Consultant, with the firm of W. Lee Helms, New York City. He was formerly Research Chemist, U. S. Stoneware Co., Ravenna, Ohio.

LYMAN BILLINGS has returned to civilian life after service as Captain in the 128th Chemical Procurement Division of the U. S. Army, and has resumed duties as Process Products Engineer with the Socony Vacuum Oil Co., Cambridge, Mass.

MACY O. TEETOR has resigned as Executive Engineer, The Perfect Circle Co., Hagerstown, Ind., and is now Owner, MOTI, Research Engineers, New Orleans.

D. W. HASKINS, formerly Assistant Design Engineer, Wallace & Tiernan Co., Inc., Newark, is now Manager, Waterbury (Conn.) Division, Sheet Metal Manufacturing Co., Inc.

C. A. RODMAN is now with the Research Dept., Fram Corp., Providence, R. I. He was Chemical Engineer at Harvard University, Cambridge, Mass.

A. F. GILL, recently returned from Germany, has assumed duties as Director of Standards, Department of Trade and Commerce, Ottawa, Canada. He was previously associated with J. T. Donald and Co., Montreal.

WILLIAM B. SINNICKSON is now Engineer of Tests, The Port of New York. He was formerly Engineer of Tests, Philadelphia.

D. GARDNER FOULKE, formerly Director of Analytical Laboratory, Foster D. Snell, Inc., Brooklyn, is now Process Electrochemist, Hanson-Van Winkle-Munning Co., Matawan, N. J.

J. R. JACKSON is now Mechanical Engineer, Association of American Railroads, Chicago. He was formerly Engineer of Tests with the Missouri Pacific Railroad Co., St. Louis.

ALBERT E. NAISH, formerly Foreman, Angelus Steel Treating Co., Los Angeles, is now in charge of the Heat Treating Dept., Western Gear Works, Lynwood, Calif.

G. E. JOHNSON is now General Manager, The Eagle-Picher Co., East Chicago, Ind. He was formerly Plant Manager of the International Smelting and Refining Co., which plant has been sold to Eagle-Picher Co.

L. G. KLINKER, formerly Captain, U. S. Army, Ordnance Division, is now Chief Engineer, The Glidden Co., Metals Refining Div., Griffith, Ind.

C. EARL WEBB, of the American Bridge Co., has been transferred from Division Engineer, Chicago, to Chief Engineer of the Pittsburgh plant.

A. R. STONE announces the opening of his own offices as Consulting Hydraulic Engineer, Foley, Ala. He was formerly Assistant Chief Engineer, Gerotor May Division, May Oilburner Corp., Baltimore, Md.

As a memorial to MAXIMILIAN TOCH, for many years very active in affairs of The Chemists' Club of New York, a committee, appointed after the receipt by the club of gifts designed to further some project in his memory, has decided upon a Toch Educational Fund. It is planned to loan the money in moderate amounts to young chemists in need of assistance with their education. Contributions will be gratefully accepted by The Club. Dr. Toch had been affiliated with A.S.T.M. since 1903, and a member of A.S.T.M. Committee D-1 on Paint, Varnish, Lacquer, and Related Products for many years.

MURRAY F. SKINKER, who has been a Personnel and Research Consultant, Montclair, N. J., is now affiliated with the Ansco Division, General Aniline and Film Corp., Binghamton, N. Y., and is concerned with work in the Engineering Department. Dr. Skinker has been very active in phases of A.S.T.M. activity and formerly was Chairman of the New York District.

J. J. CORDIANO, formerly with the Hardy Metallurgical Co., is now associated with the Buel Metals Co., Painesville, Ohio.

ALLEN H. POSTLE is now Engineer in the Components Division, Philco Corp., Philadelphia. He was formerly with the Mycalex Corp. of America, Clifton, N. J.

A. LLOYD TAYLOR, former Director of Research, Oakite Products, Inc., New York City, is now Vice-President of H. L. Shaw and Sons, Inc., Portsmouth, N. H.

CLARENCE W. FABEL, former Metallurgical Engineer, Gorham Mfg. Co., Providence, is now with the Johnson Bronze Co., New Castle, in a similar capacity.

R. B. GOOD is now associated with the Alloymet Manufacturing Corp., Brooklyn. He was formerly Chief Engineer, with Sherman and Co., New York City.

R. E. PETERSON, Manager, Mechanics Division, Westinghouse Electric Corp., East Pittsburgh, has been elected a member of the Executive Committee of the Society for Experimental Stress Analysis.

50th Anniversary of Electrical Testing Laboratories

IN NOVEMBER, 1896, three leading men in the field of Central Power Stations, C. L. Edgar, John W. Lieb, and W. S. Barstow set up a testing agency to measure the quality of lamps at the point of manufacture and at the same time they established procedures to keep the agency an independent one. From this beginning the Electrical Testing Laboratories, Inc., expanded to become a leading concern in the field of professional testing, inspection and research. Electrical Testing Laboratories have been affiliated with A.S.T.M. since 1909 and many of the Laboratory personnel have been very active in a number of phases of the Society research on standards activities. F. M. Farmer, for many years Vice-President and Chief Engineer of E.T.L., is a past president of the Society and has served A.S.T.M. in many capacities. The present representative of the membership, Mr. Gordon Thompson, Chief Engineer, is also very active in the Society serving on a number of technical committees.

NECROLOGY

(Dates of death are given where available)

A. G. FLEMING, Chief Chemist, Canada Cement Co., Ltd. Member of the Society since 1919. Mr. Fleming was for many years active in the work of Committee C-1 on Cement, serving on several of its working groups including those concerned with specifications for Portland Cement and the Sulfate Resistance. He was at one time affiliated with Committee C-11 on Gypsum. In his death the Society loses another long-time, active member who made many friends in his Society contacts.

CARL O. THIEME, Vice-President, Chief Metallurgist and Works Manager of H. Kramer & Co., whose membership in the Society dated from 1920. (December 27, 1946.) He had been concerned particularly with work on Chemical Analysis, was serving on Committee E-3 on this subject and was active in the Division of Non-Ferrous Metals, specifically serving on Subcommittee B-3 concerned with Aluminum and Magnesium.

Charles N. Forrest
1873–1946

IN the death of Charles N. Forrest the Society loses one of its long-time members who since 1901 has maintained a very active and consistent interest and participation in many phases of the Society's work. While his technical committee activities were concentrated in the work of Committees D-4 on Road and Paving Materials and D-8 on Bituminous Waterproofing and Roofing Materials, because it was in these groups that the company with which he was affiliated so many years, the Barber Asphalt Co., had its chief interest, nevertheless he also was active in A.S.T.M. work on paints and petroleum products. From 1933 to 1935 he was a member of the A.S.T.M. Executive Committee and he also served on the Papers Committee. His society activities were not limited to A.S.T.M. but included a number of other groups including the Civil Engineers, Municipal Engineers, and the Chemical Society.

For a number of years he was in railroad work, first with the Baltimore & Ohio, and later with the Long Island Railroad. He was later Chief Chemist of the New York Testing Laboratories, and continued this work with the Barber Company, becoming Manager of the Technical Department in 1923.

His friendly personality earned for him in the Society a large number of friends who regret his passing. Death occurred on December 3, 1946.

Robert J. Moore
1892–1947

THE sudden death on Monday, January 6, of Robert J. Moore, Technical Coordinator, Bakelite Corp., was a distinct shock to his many associates and friends in the Society. His friendly and dynamic personality had endeared him to a large number of technical men. Death came from a heart attack. A graduate of Cooper Institute and Columbia University, he was very active in the paint and varnish industry, at one time with Pratt & Lambert Co., and since 1930 with the Bakelite Corp. He was Manager of the Sales Development Laboratories for a number of years. Very active in a number of societies, particularly those concerned with the paint and varnish fields, he had been much interested in A.S.T.M. technical committees.

At the time of his death he was serving as chairman of the A.S.T.M. Administrative Committee on Research. Other A.S.T.M. committee affiliations included D-1 on Paint, Varnish, Lacquer and Related Products, D-9 on Electrical Insulating Materials, and D-20 on Plastics. In a number of the societies with which he was affiliated he had been honored by election to various offices.

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